STUDIES ON WESTERN AUSTRALIAN PERMIAN BRACHIOPODS

2. THE FAMILY RUGOSOCHONETIDAE MUIR-WOOD 1962

By N. W. Archbold

Department of Geology, University of Melbourne, Parkville, Victoria 3052

Abstract: Representatives of the family Rugosochonetidae (Chonetidina, Brachiopoda) from the Western Australian Permian sequences are documented. The genus *Neochonetes* Muir-Wood 1962 is discussed with the establishment of the new subgenus *Neochonetes* (*Sommeria*). The following species are revised or described: *Neochonetes* (*Sommeria*) *pratti* (Davidson), *Neochonetes* (*Sommeria*) *robustus* sp. nov., *Neochonetes* (*Sommeria*) *tenuicapillatus* sp. nov., *Neochonetes* (*Sommeria*) *afanasyevae* sp. nov., *Svalbardia narelliensis* sp. nov. Additional material indicating the presence of further species of *Neochonetes* (*Sommeria*) and a species of *Chonetinella* is described.

INTRODUCTION

Brachiopods of the suborder Chonetidina are abundant in the diverse faunas of the west Australian Permian sedimentary sequences. Representatives of the Anopliidae have been documented elsewhere (Archbold 1980a). This paper concludes the investigation of members of the Rugosochonetidae, some results of which have already appeared (Archbold 1981a, 1981b). *Neochonetes* Muir-Wood, in the form of the new subgenus *Neochonetes* (*Sommeria*), is particularly abundant at certain stratigraphical levels and species of the genus are useful for intrabasinal correlations.

Neochonetes (*Sommeria*) has a disjunct or bipolar distribution. Such a distribution for Permian chonetids was anticipated by Afanas'yeva (1978) and has been demonstrated for *Tornquistia*, *Svalbardia* and *Quinquenella* (Archbold 1980a, 1981a, 1981b).

Collections

All figured and measured specimens are housed in the following institutions as indicated by the prefix to registered numbers. CPC—Commonwealth Palaeontological Collections of the Bureau of Mineral Resources, Geology and Geophysics, Canberra, A.C.T. GSWA—Geological Survey of Western Australia, Perth, Western Australia. NMVP—National Museum of Victoria, Melbourne, Victoria. UWA—Geology Department, University of Western Australia, Nedlands, W.A. SM—South Australian Museum, Adelaide, S.A.

Stratigraphy

Marine Permian sedimentary sequences occur in the Perth, Carnarvon, Canning and Bonaparte Gulf Basins (Fig. 1) with representatives of the Rugosochonetidae in each. The sequence of the Perth Basin was revised by Playford *et al.* (1976), those of the Carnarvon and Canning Basins were reviewed by Playford *et al.* (1975) with the latter revised by Yeates *et al.* (1975) and Crowe and Towner (1976), and the Permian succession of the Bonaparte Gulf Basin was revised by Dickins *et al.* (1972).

Age

The biostratigraphic scheme of Glenister & Furnish (1961) based on ammonoids is still largely followed for Western Australia with one important exception. Those authors were unable to recognise the distinction of the Kungurian stage. Dickins (1976) attempted correlation of the Western Australian Permian sequences with the International Time Scale and he indicated the Baigendzinian-Kungurian boundary at about the level of the Baker Formation of the Carnarvon Basin. Dickins (1956) and Waterhouse (1976) favoured a slightly lower position for the boundary at the base of the Baker Formation and Archbold (1981b) suggested that the boundary may be within the Nalbia Greywacke below the Baker Formation. This latter suggestion is compatible with information on ammonoids provided by Bogoslovskaya (1976) and Cockbain (1980).

Terminology

The terminology applied to the Chonetidina has been clearly defined by Muir-Wood (1962, 1965) and Sarycheva (1970).

Palaeoecology of Massed Chonetid Occurrences

Western Australian chonetids occur in two types of coquinites, those where the individuals are disarticulated and invariably worn and those where the individuals are conjoined with excellent preservation of fine external, surface ornament.

Specimens of *Svalbardia narelliensis* sp. nov. occur by the thousands in large slabs of rock from high in the Noonkanbah Formation, Canning Basin. All specimens are disarticulated, many are worn, and other fossils are restricted to one or two isolated individuals. With few exceptions all ventral valves are convex up; dorsal valves show no preferred orientation. Elias (1962, 1966) suggested: 1, that chonetids may be gregarious and when they occur in great numbers, to the virtual exclusion of other invertebrates, they indicate waters shallower than normal for articulate brachiopods; 2, that nested ventral valves possibly indicate deposition in gently agitated water, above wave base. One such valve in valve ar-

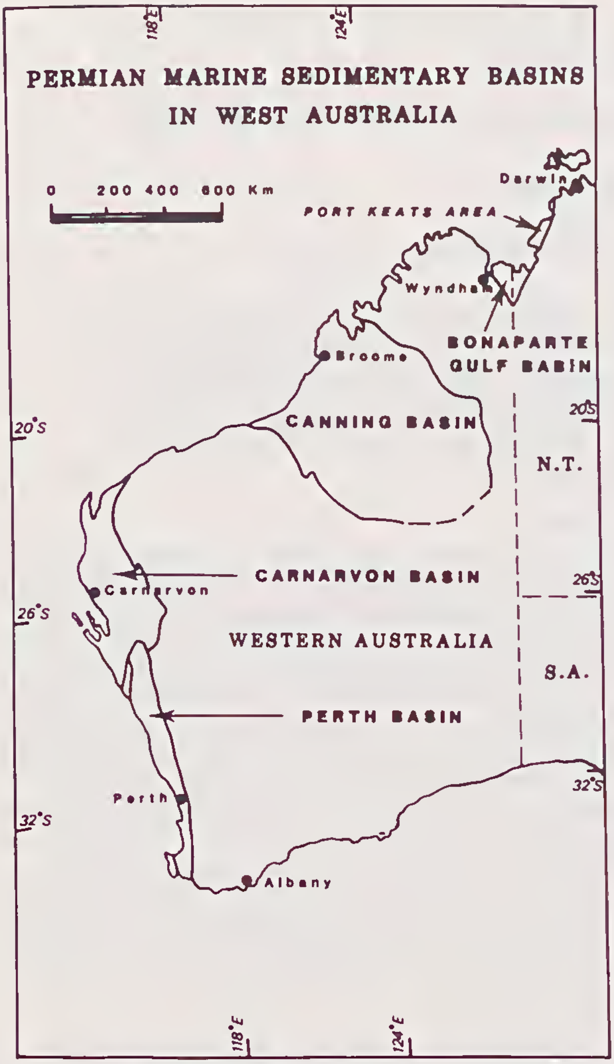


Fig. 1—Permian sedimentary basins in west Australia.

rangement of ventral valves concave up for *Svalbardia narelliensis* sp. nov. is figured herein (Fig. 2Y). Accumulations of *Neochonetes* (*Sommeria*) *afanasyevae* sp. nov. are also of disarticulated valves in the three basins in which the species occurs. The faunas of the three formations containing the species are molluscan dominant, which, in the scheme of Thomas (1958) are shallower water assemblages than brachiopod dominant assemblages.

On the other hand, accumulations of *Neochonetes* (*Sommeria*) in the Callytharra, Madeline and Wandagee Formations are often of articulated shells suggesting deposition in water below wave base. The same is true of chonetid conquinites of *Tornquistia magna* from the Bulgadoo Shale. These formations all possess brachiopod dominated assemblages inferred to reflect deeper water (Thomas 1958).

SYSTEMATIC PALAEONTOLOGY

Suborder Chonetidina Muir-Wood 1955
Superfamily Chonetacea Bronn 1862
Family Rugosochonetidae Muir-Wood 1962
Subfamily Svalbardiinae Archbold 1981

Genus **Svalbardia** Barkhatova 1970

Type Species: *Chonetes capitolinus* Toula 1815.
Diagnosis: See Archbold (1981b, p. 3).
Discussion: *Svalbardia* has been discussed by Archbold (1981b).

Svalbardia narelliensis sp. nov.

Fig. 2

Holotype: CPC19167U, a dorsal valve.
Etymology: From Narelli Rockhole, Canning Basin, Western Australia.
Location and Occurrence: Upper Noonkanbah Formation, Canning Basin.

The following B.M.R. localities yielded several hundred specimens of *Svalbardia narelliensis* which were examined for the present investigation. Additional localities in the Canning Basin that have yielded *Svalbardia* are documented in Dickins and Jell (1974) who identified the species as a representative of *Neochonetes*. L.3., Lat. 20°08'S, Long. 127°58'E, 4.8 km west of Balgo Mission; L.101., Lat. 20°08'S, Long. 127°58'E, 4.8 km west of Balgo Mission, L.610., Lat. 20°09'S, Long. 127°56'E, 1.2 km south of Narelli Rockhole.

Measurements: The specimens measured for Table 1 are paratypes from L610 and have the registered numbers CPC 19167A to 19167Z; CPC19168A to 19168E.

Description: external. Shell length is about three-quarters maximum width which occurs about mid-length of the shell. The ventral valve is convex, usually without a sulcus, although a slight flattening or a very shallow sulcus is visible on rare specimens. The anterior commissure is not flexed. The dorsal valve is normally flat or rarely gently concave. The interareas are narrow, that of the ventral valve being striate parallel to its width. The exterior of the shell is smooth except for concentric growth lines. Worn ventral valves exhibit a surface feature of pits arranged in concentric rows formed by exposure of the taleolac. Worn dorsal valves, in which growth lines may still be visible, exhibit a pseudocapillate exterior. Hinge spines are worn on all examined specimens. However, spine base canals 1 to 1.5

Table 1

Size Ranges of Populations of *Svalbardia narelliensis* sp. nov. (mm)

Maximum Width	Hinge Width	Ventral Length	Dorsal Length	Thickness
12.4-20.5	8.6-19.0	10.9-15.7	8.9-11.6	2.7- 4.3

mm apart are clearly visible in the ventral interarea of several specimens. Where traces of spines remain they indicate the spines emerged at a low angle to the hinge. INTERNAL. the ventral median septum is over three-quarters valve length and arises under the delthyrium as a high pronounced structure. One ventral valve (CPC19167H) possesses two parallel, weakly impressed striations adjacent to the septum. Vascular trunks and muscle scars are poorly impressed. Specimen CPC19167G exhibits a pair of small adductor scars adjacent to the posterior third of the median septum. The teeth are small and sharp.

The dorsal median septum is just over two-thirds valve length and is higher and broader posteriorly. The alveolus is small but distinct and, at times, deep. The lateral septa are stout and arise anterior to the alveolus, where they are fused with the median septum to form a low platform. The sockets are deep with pronounced inner socket ridges. The brachial ridges are indistinct and their anterior recurved portions are only slightly raised in mature individuals. The cardinal process is low but distinct, externally quadrilobed, internally bilobed. The interior of the dorsal valve is finely papillose with the anterior papillae being arranged in radiating rows.

Delthyrial structures are poorly known, however, a minute pseudodeltidium is present in the apex of the delthyrium of specimen CPC19167G. None of the specimens exhibit a chilidium.

DISCUSSION: *Svalbardia narelliensis* is morphologically similar to *Svalbardia thomasi* Archbold (1981b) from the Baker Formation and Nalbia Greywacke of the Carnarvon Basin. *S. narelliensis* possesses, in mature individuals, only weakly raised anterior recurved portions of the brachial ridges. In other respects *S. narelliensis* is similar to *S. thomasi* and they are of approximately the same age. *S. narelliensis* attains a larger size than *S. thomasi*. *S. thomasi* was compared with many boreal occurrences of the genus by Archbold (1981b); the boreal species usually being larger and possessing prominently raised anterior recurved portions of the brachial ridges.

AGE: *Svalbardia* in the Nalbia Greywacke and Baker Formation (Archbold 1981b) indicates an earliest Kungurian age. *Svalbardia* occurs high in the Noonkanbah Formation, beneath the Middle Kungurian Lightjack Formation (see discussion under *Neochonetes* (*Sommeria*) *afanasyevae* sp.nov.). It therefore appears that the Noonkanbah Formation contains Baigendzinian and earliest Kungurian faunas.

TABLE 2

REPRESENTATIVE REPORTS OF SPECIES OF *Neochonetes* MUIR-WOOD INDICATING TIME RANGE AND GEOGRAPHICAL DISTRIBUTION OF STOCKS WITHIN THE GENUS.

1. Stock of *Neochonetes* (*Neochonetes*) *carboniferus* (Keyserling 1846)

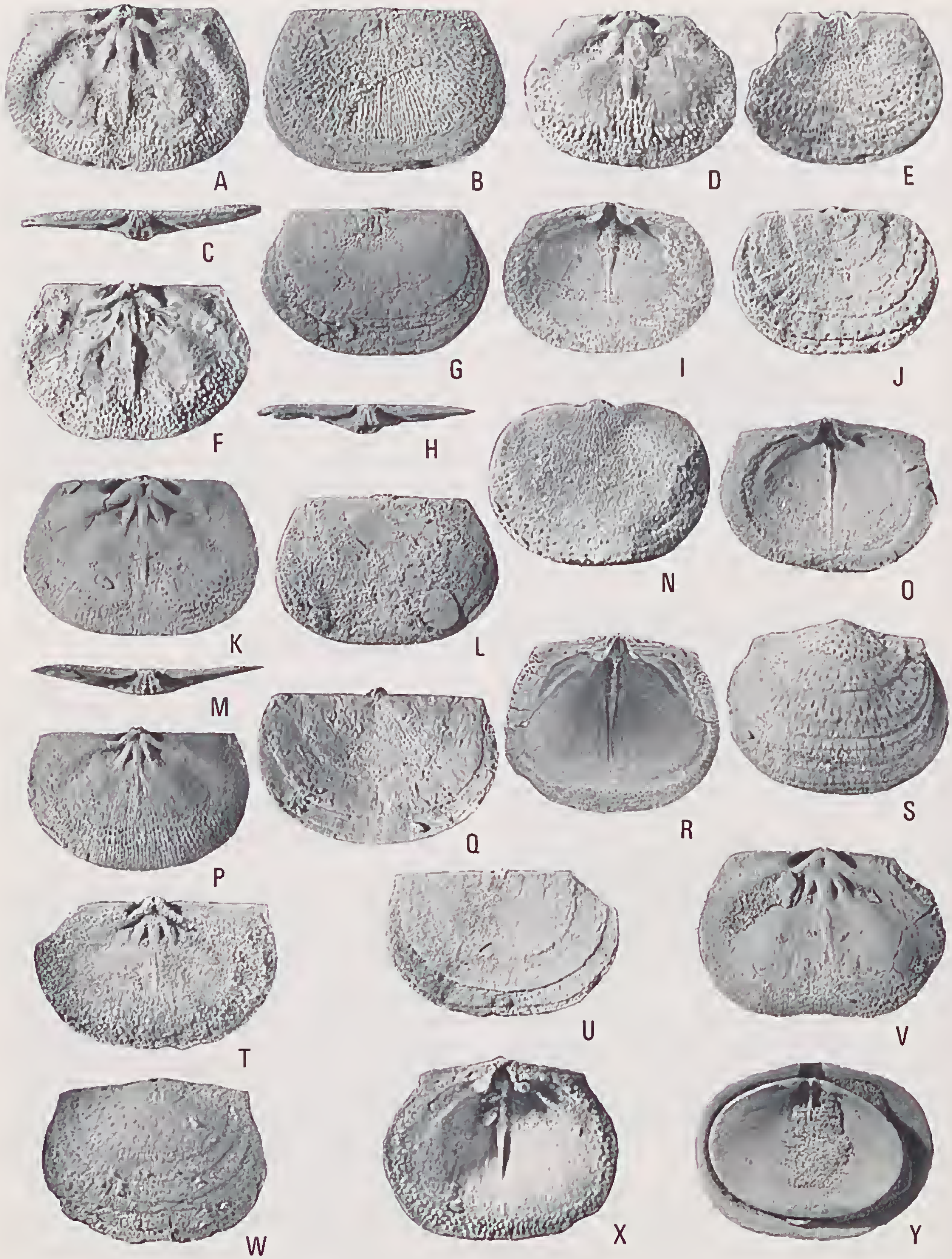
Chonetes sarcinulata var. *carbonifera* Keyserling 1846; North Urals; Late Carboniferous. *Neochonetes carboniferus* Afanas'yeva 1975b; Russian Platform; Kasimovian-Gzhelian. *Neochonetes? donetzianus* Afanas'yeva 1975b; Donetz Basin; Middle Carboniferous. *Chonetes carboniferus* Semenova 1972; Kuibyshev Region; Bashkirian. *Chonetes ex* gr. *carboniferus* Lapina 1958; Kharaulakh Mts, NE USSR; Late Carboniferous. *Neochonetes acanthophorous* Winkler-Prins 1968; Cantabrian Mts Spain; Bashkirian. *Chonetes pseudovariolatus* Loczy 1897; Kansu Province, China; Late Carboniferous. *Chonetes pseudovariolatus* Schellwien 1911; Nth Nan-Shan, China; Late Carboniferous. *Chonetes carbonifera* Chao 1928; China, widespread; Middle & Late Carboniferous. *Neochonetes puanensis* Liao 1979; Western Guizhou Province, China; Gzhelian. *Chonetes* cf. *carboniferus* Ozaki 1934; Korea; Late Carboniferous. *Neochonetes permicus* Grushenko 1975; Donetz Basin; Asselian.

2. Stock of *Neochonetes* (*Neochonetes*) *granulifer* (Owen 1852)

Chonetes granulifer Owen 1852; Iowa, U.S.A.; Pennsylvanian. *Chonetes dominus* King 1938; Texas, U.S.A.; Pennsylvanian. *Chonetes granulifer*. var. Dunbar & Condra 1932; Nebraska, U.S.A.; Pennsylvanian. *Neochonetes granulifer* Spencer 1970; Kansas, Missouri, U.S.A.; Pennsylvanian-Sakmarian. *Neochonetes granulifer* Brand 1970; England; Late Carboniferous. *Chonetes* sp. C Brand 1970; Scotland; Late Carboniferous. *Chonetes (Chonetinella) granulifer* Böger & Fiebig 1963; Germany; Stephanian. *Leptaena variolata* d'Orbigny 1842; Bolivia; Asselian-Sakmarian. *Chonetes variolatus* Thomas 1930; Peru; Asselian-Sakmarian.

3. Stock of *Neochonetes* (*Sommeria*) *pratti* (Davidson 1859)

Chonetes pratti Davidson 1859; Western Australia; Sakmarian. *Chonetes arabicus* Hudson & Sudbury 1959; Oman Peninsula; Sterlitamakian. *Neochonetes variolatus* Termier *et al.* 1974; Afghanistan; Sterlitamakian. *Neochonetes variolatus* Fantini Sestini 1965b; Karakorum; Sakmarian? *Neochonetes forbesi* Czarniecki 1969; Spitzbergen; Asselian-Sakmarian. *Chonetes variolatus* Zavodovsky & Stepanov 1971; Kolyma, USSR; Asselian. *Neochonetes tschernyschewi* Barkhatova 1970; Urals; Sakmarian. *Neochonetes fredericksi* Archbold 1979; Pechora Basin, USSR; Artinskian. *Chonetina superba* Gobbett 1964; Spitzbergen; Late Kungurian. *Chonetina?* cf. *C. superba* Brabb & Grant 1971; Alaska; Late Kungurian. *Neochonetes* sp. Bamber & Waterhouse 1971; Yukon; Late Kungurian. *Neochonetes asseretoi* Fantini Sestini 1964; Iran; Late Kungurian-Kazanian. *Chonetes wageri* Muir-Wood 1941; Himalaya; Chhidruan. *Neochonetes (Sommeria)* sp. herein; Western Australia; Chhidruan.


A
B
D
E
C
G
I
J
F
H
N
O
K
L
M
R
S
P
Q
U
V
T
W
X
Y

Subfamily Rugosochonetinae Muir-Wood 1962
Genus **Neochonetes** Muir-Wood 1962
(= *Quadranetes* Sadlick 1963)

Type Species: *Chonetes dominus* King 1938

Diagnosis: *Neochonetes* includes medium to large sized weakly to moderately concavo-convex, rugosochonetinids with finely capillate external ornament and a feebly to distinctly developed sulcus; dorsal interior with distinct alveolus, lateral septa, median septum and brachial ridges; inner socket ridges well developed and outer socket ridges may be present. Ventral valve with prominent septum, two parallel vascular trunks forming prominent ridges, and hinge spines at a low to moderate angle to hinge line.

Discussion: The long time range and large number of species undoubtedly account for the rather broad generic diagnosis. Within *Neochonetes* several groups or stocks may be recognised and generalised evolutionary trends defined.

One of the early stocks of *Neochonetes*, arising in the Bashkirian, characterised by hinge spines at a low angle (may curve to higher angle distally), a low convexity of the shell, a moderately transverse outline often with small ears, the hinge line usually being the position of maximum width, and an obsolescent sulcus, can be referred to as the group of *Neochonetes carboniferus* (Table 2).

Closely allied to the *Neochonetes carboniferus* stock is the group of *Neochonetes granulifer* (Table 2). This stock also possesses hinge spines at a low angle (one exception being the Late Mississippian *Neochonetes oklahomensis* (Snider) as redescribed by Branson (1964) which has hinge spines at 45°) a moderate to low convexity and a broad shallow sulcus, the latter usually more strongly developed than in the *Neochonetes carboniferus* stock. Younger variants of the *Neochonetes granulifer* stock are often, but not invariably, more transverse than older variants and possess hinge spines at a greater angle to the hinge. South American occurrences of the stock remain poorly understood despite attempts at the redescription of *Neochonetes variolatus* (d'Orbigny) by Koninck (1847) and Kozlowski (1914). The binomen *Chonetes variolatus* has at times been applied to members of the *Neochonetes carboniferus* stock (Gorskii & Timofeeva 1950) indicating a degree of confusion as to the nature of *Neochonetes variolatus*. The only representative of *Neochonetes* from the Late Permian of New Zealand (Waterhouse 1964, 1976), a large species with hinge spines at a low angle and a gentle broad sulcus may be a migratory descendent of the *N. granulifer* stock. Waterhouse (1964) compared the New Zealand *N. beatusi* with several species of the *N. granulifer* stock. A species in the Bowen Basin (Dear 1971) possesses a maximum width at midlength of the shell and a greater convexity of the ventral valve.

A third group within *Neochonetes* is the *Neochonetes pratti* stock here named *Neochonetes* (*Sommeria*). This stock is characterised by large size, ventral hinge spines at an angle of about 40° to 45°, often a prominent sulcus and a maximum width invariably anterior of the hinge.

Boreal species of the stock replace the older *N. carboniferus* stock in the northern Urals during the Sakmarian (Barkhatova 1964). Few boreal species are well documented, exceptions being the early Artinskian Pechora Basin species *N. fredericksi* Archbold 1979 and the Sakmarian *N. tschernyschewi* Barkhatova 1970 from the Urals.

During the Kungurian and subsequent stages, *Neochonetes* again underwent subtle changes in morphology, but stocks are not clear because of the paucity of documented species. Small species of *Neochonetes* from the Zechstein of Germany and England (Schauroth 1856, Trechmann 1944) and the Kazanian of Armenia (Sokolskaya 1965) exhibit a trend to weakly developed ornament and an obsolescent sulcus. Discussions and illustrations of the Zechstein species (Davidson 1880, Malzahn 1957 and Muir-Wood 1962) indicate that they belong to a separate stock within *Neochonetes*.

Other representatives of *Neochonetes* of Kungurian and younger age do not exhibit obsolescent ornament or an obsolescent ventral sulcus, although the species may be small in size. *Chonetes pinegensis* Kulikov (1974) from the Kazanian of northern European USSR, *Neochonetes* cf. *pinegensis* of Stepanov *et al.* from the Kazanian of the Kanin Peninsula and *Chonetes* sp. of Licharew (1913) from the late Kungurian of Kirillov are all small species with distinct ornament and ventral sulcus. The wide variety of morphologies of Kungurian and younger neochonetids probably reflects greater isolation of specific gene pools resulting from the elimination of seaways for migratory exchanges and from other environmental factors such as increase in salinity (the latter undoubtedly affecting the Zechstein stock).

Subgenus **Neochonetes (Sommeria)** subgen. nov.

Type Species: *Chonetes prattii* Davidson 1859.

Fig. 2—*Svalbardia narelliensis* sp. nov.
All specimens from the Noonkanbah Formation, Canning Basin; A-C, Holotype CPC 19167U, Dorsal valve in ventral, dorsal and posterior views. x3; D, CPC 19168B, Dorsal valve in ventral view. x3; E, CPC 19168C, Dorsal valve in ventral view. x3; F-H, CPC 19167Z, Dorsal valve in ventral, dorsal and posterior views. x3; I, CPC 19167R, Ventral valve in dorsal view. x3; J, CPC 19168 E, Dorsal valve in dorsal view. x3; K-M, CPC f19167V, Dorsal valve in ventral, dorsal and posterior views. x3; N, CPC 19168D, Dorsal valve in dorsal view. x3; O, CPC 19167B, Ventral valve in dorsal view. x2; P-Q, CPC 19167X, Dorsal valve in ventral and dorsal views. x3; R, CPC 19167H, Ventral valve in dorsal view. x2.5; S, CPC 19167G, Ventral valve in ventral view. x3; T-U, CPC 19168F, Dorsal valve in ventral and dorsal views. x3; V, CPC 19168A, Dorsal valve in ventral view. x3.25; W, CPC 19167F, Ventral valve in ventral view. x3; X, CPC 19167K, Ventral valve in dorsal view. x3.25; Y, CPC 19168G, Valve in valve arrangement, dorsal view. x3.5.

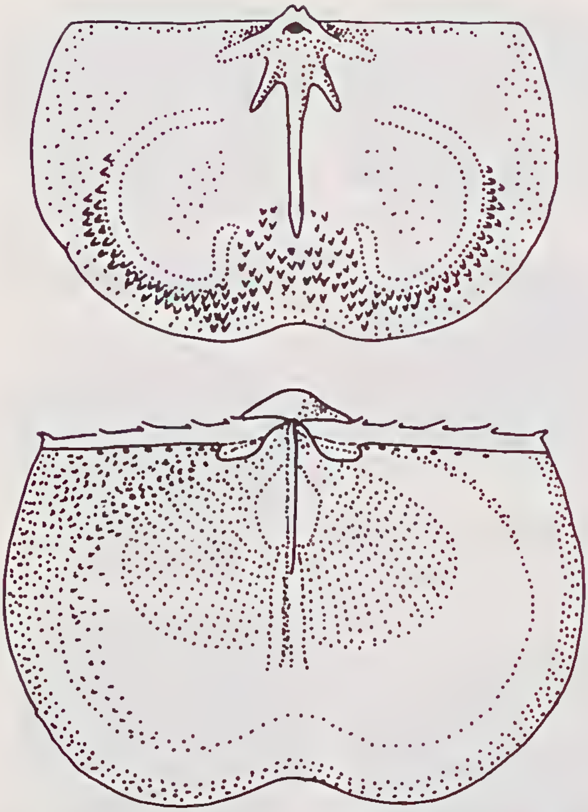


Fig. 3—The internal morphology of *Neochonetes* (*Sommeria*) *pratti* (Davidson): after Muir-Wood (1962, fig. 3, p. 13).

Etymology: Named in honour of Ferdinand von Sommer, pioneer geologist in Western Australia.

Diagnosis: Similar to *Neochonetes* (*Neochonetes*) but sulcus usually conspicuously developed, gentle fold often developed in the dorsal valve, a greater convexity of the ventral valve and hinge spines at about 40° to 45°. Maximum width of mature shells usually anterior of the hinge. Interior as for *Neochonetes* (*Neochonetes*).

Discussion. Although, as discussed above, several stocks can be identified in the genus *Neochonetes*, to give these full generic status is considered premature because the stocks do exhibit a degree of morphological overlap. The stock of *Neochonetes pratti*, outlined above, from Western Australia and the Boreal Realm is considered to belong to the new subgenus *Sommeria*. Many of the poorly known boreal species are compared with *Neochonetes* (*Sommeria*) *pratti* below. Fig. 3 shows the internal morphology of *Neochonetes* (*Sommeria*) *pratti*.

Neochonetes (Sommeria) pratti (Davidson) 1859
Figs 4, 5, 6.

1859 *Chonetes prattii* Davidson, *The Geologist* 2: 116, pl. 4, figs 9-12.
1890 large *Chonetes* Etheridge, *Annu. Rep. Dept. Mines N.S.W.* 1889: 239.
1892 *Chonetes pratti*; Newton, *Geol. Mag.* (3) 9: 468, 542, pl. 14, figs 1-12.
1893 *Chonetes pratti*; Newton, *Rep. Br. Assoc. Advmt. Sci.* 1892: 725.
1903 *Chonetes pratti*; Etheridge, *Bull. geol. Surv. W. Aust.* 10: 23.
1907 *Chonetes pratti*; Etheridge, *Bull. geol. Surv. W. Aust.* 27: 31, pl. 8, fig. 2; pl. 9, fig. 7; pl. 10, fig. 2.
1910 *Chonetes pratti*; Glauert *partim*, *Bull. geol. Surv. W. Aust.* 36: 86.
1931 *Chonetes pratti*; Hosking, *J. Proc. Roy. Soc. W. Aust.* 17: 19.
1952 *Chonetes pratti*; Guppy *et al.*, *19th Int. Geol. Cong., Alger., Sym. Gond.*, 110.
1962 *Neochonetes pratti*; Muir-Wood, *Monograph Br. Mus.* (*Nat. Hist.*) p. 13, pl.11, figs 7-8.

Holotype: (by monotypy) BM(NH), BB 41082. A complete shell (valves separate) Figured by Davidson (1859), Newton (1892), and Muir-Wood (1962).

History of Discovery: The locality of the type specimen, from the collection of Mr. Pratt was unknown to Davidson (1859). Newton (1892, 1893) considered that the type specimen came from the Irwin River, Western Australia, after examination of specimens of a chonetid brachiopod from that locality, particularly in view of the nature of preservation of the specimens available to him. He further considered the holotype part of the Strzelecki collection but this is unlikely as Strzelecki's investigations and collections were made in eastern Australia at an earlier date.

Permian sediments were discovered by Commander J. L. Stokes between 1837 and 1843 near Port Keats (Bonaparte Gulf, Northern Territory). *Neochonetes* (*Sommeria*) *afanasyevae* sp. nov. from that locality is not close to *Chonetes pratti* and is preserved as moulds and casts, whereas the type specimen of *Chonetes pratti* is a well preserved shell. Samuel Peace Pratt (1789-1863) was an active member of the Geological Society of London and spent much time arranging the collections of the Society (Woodward 1907). As a result Pratt had access to collections from the Irwin River sent to the Society by the Gregory Brothers and von Sommer (Archbold 1981c) and hence the specimen in his collection probably comes from one of these sources.

It appears that Davidson's original specimen probably

Fig. 4—*Neochonetes* (*Sommeria*) *pratti* (Davidson).
All specimens from the Fossil Cliff Member of the Holmwood Shale, Fossil Cliff, Irwin River; A-B, GSWA F 11038, Dorsal valve in dorsal and ventral views. x1.75; C, GSWA F 11022, Ventral valve in dorsal view x2; D-E, GSWA F 11039, Dorsal valve in dorsal and ventral views. x1.75; F-G, GSWA F 11023, Ventral valve in dorsal and ventral views. x1.75; H-I, GSWA F 11027, Ventral valve views. x1.5; J-K, GSWA F 11041, Dorsal valve in ventral and dorsal views. x1.75; L-M, GSWA F 11044, Dorsal valve in dorsal and ventral views x1.75 and 1.5; N-O, GSWA F 11018, Shell in ventral and dorsal views x1.75; P, GSWA F 11031, Ventral valve in ventral view x2; Q, GSWA F 11046, Dorsal valve in ventral view x2.5; R-S, GSWA F 11043, Dorsal valve in dorsal and ventral views x 1.75; T, GSWA F 11045, Dorsal valve in ventral view x2; U, GSWA F 11030, Ventral valve in ventral view x2.

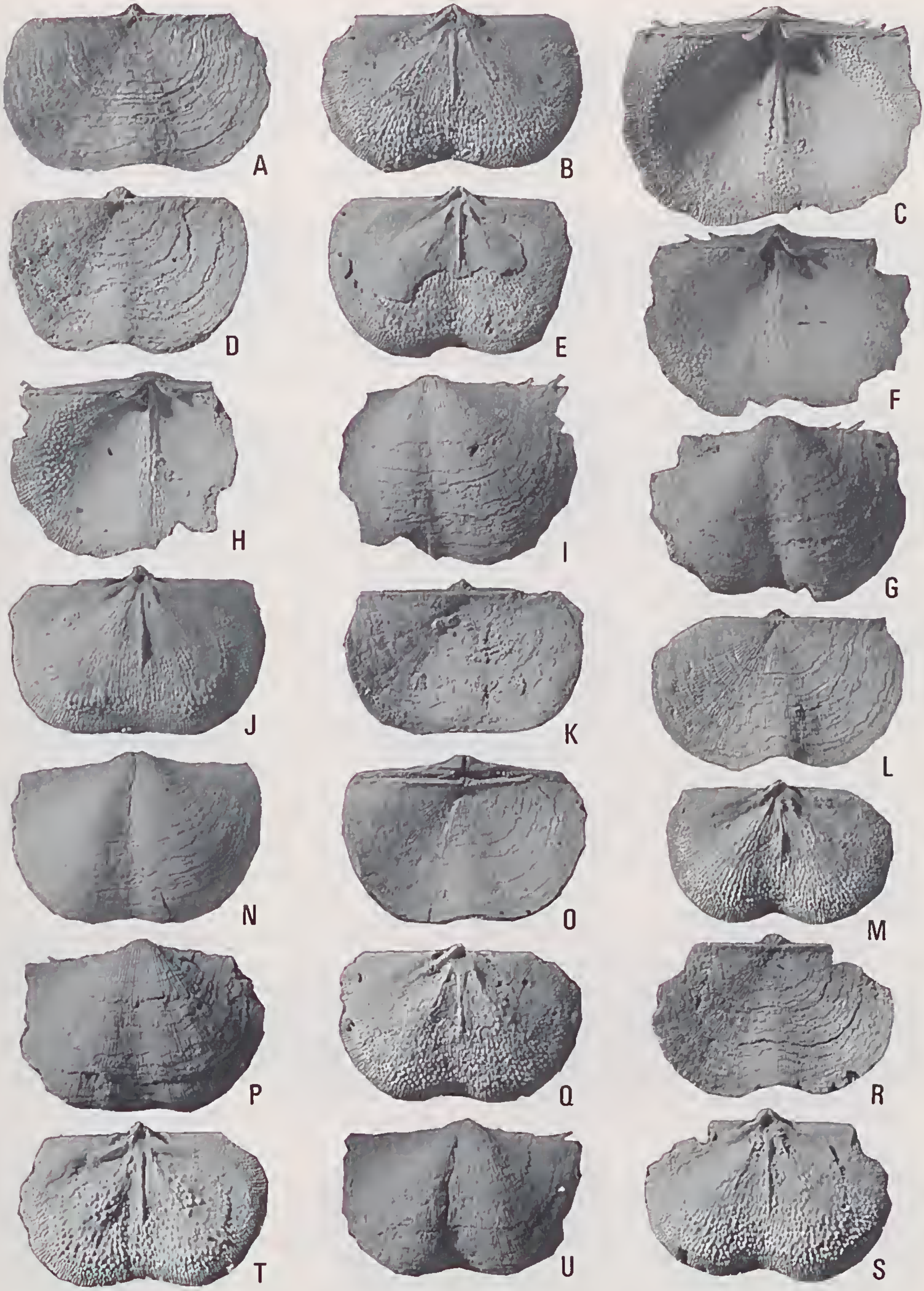

A
B
C
D
E
F
H
I
G
J
K
L
N
O
M
P
Q
R
T
U
S

TABLE 3

SIZE RANGES OF POPULATIONS OF *Neochonetes* (*Sommeria*) *pratti* (mm)

Stratigraphic Horizon	Maximum Width	Hinge Width	Ventral Length	Dorsal Length	Thickness
Fossil Cliff	18.0-29.0	13.8-24.0	11.5-21.0	11.7-19.0	4.0- 8.8
Callytharra	12.0-28.0	12.0-28.0	11.5-21.2	8.3-19.0	4.0-10.0
Jimba Jimba	30.0	24.7	20.0	17.3	7.7
Nura Nura	14.4-31.4	14.4-31.4	7.0-14.0	7.8-14.0	2.8- 4.1

came from Fossil Cliff on the Irwin River where the Fossil Cliff Member of the Holmwood Shale outcrops.

MATERIAL: Perth Basin: GSWA F 11017-11046, 4 conjoined shells, 14 ventral valves (VV) and 12 dorsal valves (DV) from Fossil Cliff, Irwin River, Fossil Cliff Member of the Holmwood Shale. Carnarvon Basin: CPC 19863-19865, 19867-19868, 3VV and 2DV from BMR locality GW74, about 1.2 km west of Callytharra Springs, near base of Callytharra Formation; CPC 19866, DV from BMR locality GW87, Lat. 25°32'S, Long. 115°30'E about 40 to 45 m above base of Callytharra Formation; GSWA F 11047A-11047I, one conjoined shell, 5VV, 4DV, from GSWA locality 30137A, Glenburgh (1920) run 7/079, pt. 1312, RMH BK6, Yard Grid 387-803, Callytharra Formation; CPC 19869, a conjoined shell, from BMR locality WO3, Lat. 25°02'75"S, Long. 114°58'E, type section of Jimba Jimba Calcarenite. Canning Basin: CPC 19880A-19880D, three conjoined shells and 1VV from BMR locality KNuA, 2.4 km south-west of Paradise Homestead (Lat. 18°02'50"S, Long. 124°31'00"E), Nura Nura Member of Poole Sandstone; CPC 19881A-19881V, three internal moulds of conjoined shells, 5 internal moulds of VV, 2 external moulds of VV, 7 external moulds of DV and 6 internal moulds of DV, from BMR locality KPA54, 23.5 km at 120° from Mt. Tuckfield in the southern part of the St. George Range, near base of Pool Sandstone.

DIAGNOSIS: Large *Neochonetes* (*Sommeria*). Ventral sulcus well developed; dorsal fold low but distinct. Exterior ornament of fine capillae, on average 4 per mm at 1 and 3 cm from umbones.

DESCRIPTION: EXTERNAL. Length of the shell is just over two-thirds the maximum width. Maximum width about mid-length of the shell, hinge width being less than maximum width. The ventral valve is strongly convex, especially in gerontic individuals. The sulcus is distinct, sometimes deep and produces a flexure on the anterior commissure of the valve. The dorsal valve is gently concave with a low median fold or flexure corresponding to the sulcus of the ventral valve. The interareas are narrow. The chilidium is small and seldom preserved; the pseudodeltidium appears to be absent. Ornament is of fine capillae which increase by either bifurcation or intercalation. Growth lines are distinct, variable and may be lamellose. Spinule bases are randomly scattered on well preserved shells. Spines along the ventral interareas are distinct with at least six on each side of the umbo of large individuals. The angle of emergence is about 40°. Spines up to 1.5 mm in length have been observed but are broken.

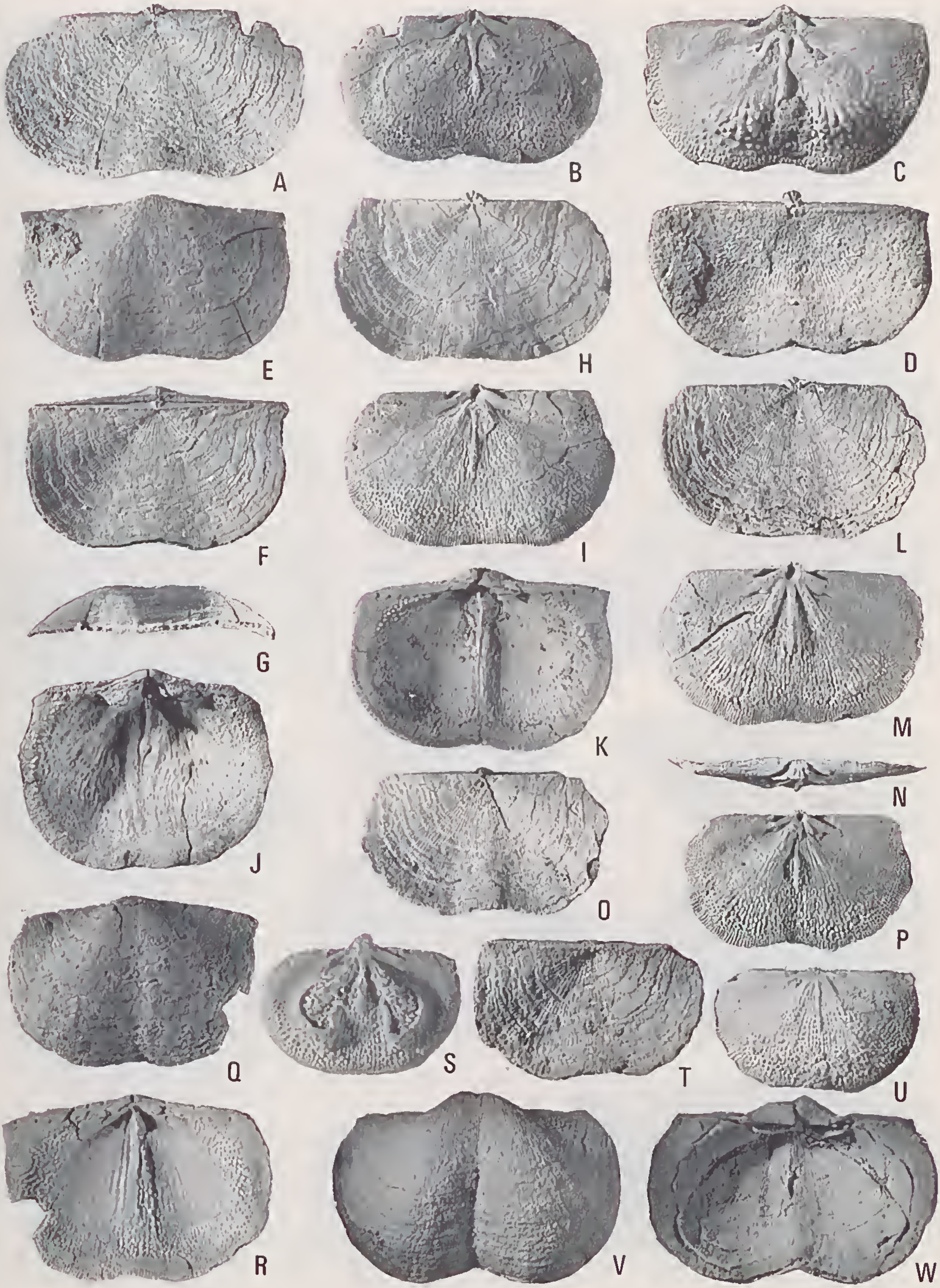
INTERNAL. The ventral median septum is up to half valve length and is high posteriorly, arising 1 to 2 mm in front of the umbo. Anteriorly two parallel vascular trunks form prominent ridges adjacent to the septum. The adductor muscle scars the indistinct while the diductors are strongly impressed. The teeth are small and sharp. With the exception of the region of the muscle scars, which is smooth or striate, the interior of the ventral valve is papillose. The cardinal process is externally quadrilobate and internally bilobed. The dorsal median septum is two-thirds valve length and arises in front of the deep alveolus as do the short lateral septa. The sockets are deep with pronounced inner socket ridges and feeble outer socket ridges. The brachial ridges are distinct. The interior of the dorsal valve is papillose, the papillae being arranged in radiating rows.

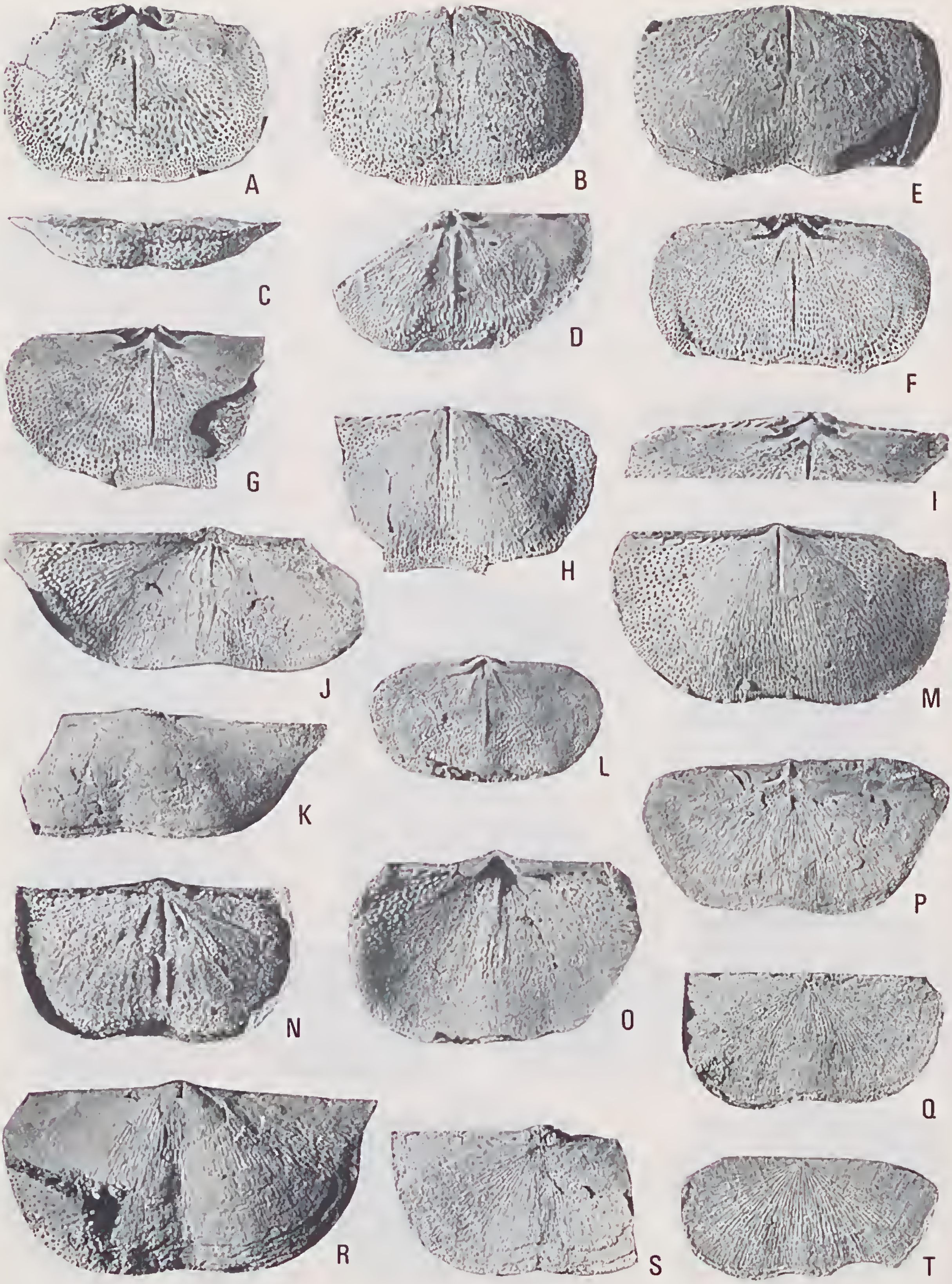
DISCUSSION: A report of the species from the Mingenew Formation, Perth Basin, by Etheridge (1907b) has been shown to refer to the strophalosiid *Mingenewia* (Archbold 1980b). The occurrence of the species in the Nura Nura Member, previously reported by Guppy *et al.* (1952), is confirmed but several individuals from that horizon are more transverse than specimens from the Fossil Cliff Member or the Callytharra Formation. Ecological factors are probably the cause of the variation. The Nura Nura specimens were found in a coarse sandstone, quite unlike the fine grained muddy marls and siltstones of the more southerly occurrences.

Zavadovsky & Stepanov (1971, pl. 23, figs 8a-8b) figured a large specimen of a *Neochonetes* from the Early Permian (Asselian) Paren horizon of the Kolyma region, far north-east USSR, as *Chonetes variolatus*

Fig. 5—*Neochonetes* (*Sommeria*) *pratti* (Davidson)

A-U from Callytharra Formation, Carnarvon Basin; V-W from Jimba Jimba Calcarenite, Carnarvon Basin; A-B, GSWA F 11047B, Dorsal Valve in dorsal and ventral view. x1.75 and x1.5 respectively; C-D, CPC 19866, Dorsal valve in ventral and dorsal views. x2; E-G, GSWA F 11047E, Shell in ventral, dorsal and anterior views. x1.75; H-I, GSWA F 11047G, Dorsal valve in dorsal and ventral views. x1.75; J, CPC 19864, Ventral valve in dorsal view. x1.5; K, GSWA F 11047D, Ventral valve in dorsal view. x1.75; L-N, GSWA F 11047F, Dorsal valve in dorsal, ventral and posterior views. x1.75; O-P, GSWA F 11047I, Dorsal valve in dorsal and ventral views. x1.75; Q-R, GSWA F 11047C, Ventral valve in ventral and dorsal views. x1.75; S, CPC 19868, Dorsal valve in ventral view. x2.5; T-U, CPC 19867, Dorsal valve in dorsal and ventral views. x2.5 and 2.25 respectively; V-W, CPC 19869, Shell in ventral and dorsal views. x1.5.


A
B
C
E
H
D
F
I
L
G
K
M
N
J
O
P
Q
S
T
U
R
V
W


A
B
E
C
D
F
G
H
I
J
M
K
L
P
N
O
Q
R
S
T

(d'Orbigny). It is slightly more transverse than *Neochonetes* (*Sommeria*) *pratti* and possesses similar interareas. The external ornament is poorly known because of decortication of the shell.

Czarniecki (1969) compared *Neochonetes forbesi* (Gobbett), from the Asselian-Sakmarian Treskelodden Beds and the Upper and Lower Wordiekammen Limestone of Spitzbergen, with *N.* (*S.*) *pratti*. Gobbett's species is, however, much smaller (one-third the size) than the Western Australian species. Nevertheless, comparison is warranted as *Neochonetes forbesi* possesses a well rounded outline (Czarniecki 1969, pl. 4, fig. 7a). *Neochonetes* (*Sommeria*)? *superbus* (Gobbett) from the Middle Brachiopod Chert, Bunsow Land, Spitzbergen of Late Kungurian age, is a large species comparable in size with the largest specimens of *Neochonetes* (*Sommeria*) *pratti*. *Neochonetes* (*Sommeria*)? *superbus* is, however, a distinct species, by being more transverse, possessing weaker ornament and possessing a much weaker convexity in profile.

Other reports of neochonetids from the Permian of the USSR and Asia that indicate species related to *N.* (*S.*) *pratti* are mentioned briefly. Detailed comparisons are impossible since the species mentioned are usually based solely on ventral valves or on poorly preserved material. *Chonetes lobata* Grünewaldt (1860, pl. 3, fig. 6) from the Urals is a finely capillate species, widest anterior of the hinge with a shallow sulcus. *Chonetes dalmanoides* of Fredericks (1915, pl. 9, fig. 5) from beds near Krasnoufimsk, European USSR, underlying those from which in 1912 he recorded *Chonetes variolatus* d'Orbigny, is a smaller species with a rounded outline and shallow sulcus and is probably closer to *Neochonetes* (*Neochonetes*) than *N.* (*Sommeria*). *Chonetes dereimsi* Douglas 1936 of probable Kungurian age from south western Persia possesses a similar swollen ventral valve to that of *N.* (*S.*) *pratti* and is finely capillate, but, it is half the size of adult specimens of *N.* (*S.*) *pratti*. *Neochonetes variolatus* of Fantini Sestini (1965b) from the Karakorum is represented by ventral valves with a distinct sulcus and a maximum width anterior of the hinge line in some specimens. The early Permian *Neochonetes* sp. of Acharyya *et al.* (1975, pl. 2, figs H, I, J) is also similar to *Neochonetes* (*Sommeria*) *pratti* in outline but appears to have less well developed dorsal septa, and the specimens are smaller than mature individuals of the Western Australian species and hence may be juveniles. Similar comments can be made for the record of two varieties of *Chonetes carboniferus* from the Sakmarian of Sikkim recorded by Sahni & Srivastava (1956, pl. 36, figs 12-16). This is a species that possesses a sulcus invariably more weakly developed than the Western Australian species. The small Sterlitamakian species, *Chonetes arabicus* Hudson & Sudbury (1959, pl. 3, figs 6-16 and ? pl. 4, figs 14-18) also possesses a hinge line shorter than the maximum width of the shell as well as a distinct sulcus, but the Arabian species, while the same age as the Western Australian species, is much smaller in size.

Age: Latest Tastubian to Aktastinian.

Neochonetes (Sommeria) robustus sp. nov.

Fig. 7

?1912 *Chonetes pratti*; Glauert, *Rec. W. Aust. Mus.* 1:75.

1965 *Chonetes pratti*; Edgell, *Ann. Rept. geol. Surv. W. Aust.* 1964: 65, pl. 34, fig. 2.

HOLOTYPE: CPC 19886M from BMR Locality WB182.

MATERIAL: Paratypes: CPC 19885A-19885C, 2 external moulds of DV and 1 internal mould of a VV, from BMR locality WB51, 3.6 km on a bearing 225° from Keogh Hill, Madeline Formation, Carnarvon Basin; CPC 19886A-P, 2 external moulds of DV, 1 internal mould of a DV, 4 external moulds of VV, 3 internal moulds of VV and 6 internal moulds of conjoined shells from BMR locality WB182, 3.5 km bearing 358° from Monument Bore, Madeline Formation; GSWA F 5285, 5287, 5288, 3 internal moulds of VV and 1 external mould of a VV from hillside 4.8 km west of Arrino, Mingenew Formation, Perth Basin.

TABLE 4
SIZE RANGES OF *N.* (*S.*) *robustus* sp. nov. (mm)

Maximum Width	Hinge Width	Ventral Length	Dorsal Length	Thickness
10.2-20.0	10.5-15.0	6.8-13.5	7.8-12.8	4.0-5.6

DIAGNOSIS: Small for genus, strongly convex ventral valve, weakly concave dorsal valve. Sulcus weak to absent. Shell outline subquadrate, globular, length of shell between 0.67 and 0.75 the maximum width.

DESCRIPTION: EXTERNAL. Maximum width is at about mid length of the shell. The sulcus is either absent or present only in the form of a gentle median flattening of the ventral valve. The interareas are narrow. Ornament consists of fine capillae, 4 per 1 mm on specimen CPC 19886A 9 mm from the umbo, and delicate growth lines. Hinge spines apparently emerge at about 40° to the hinge.

INTERNAL. The ventral septum arises close to the umbo,

Fig. 6 — *Neochonetes* (*Sommeria*) *pratti* (Davidson)
All specimens from the Nura Nura member, Poole Sandstone, Canning Basin; A-C, CPC 19881A, Internal mould of shell in dorsal, ventral and anterior views. x2; D, CPC 19881R, latex replica of dorsal valve internal mould. x2; E-F, CPC 19881B, Internal mould of shell in ventral and dorsal views. x2.25; G-I, CPC 19881C, Internal mould of shell in dorsal, ventral and postero-dorsal views. x2, x2 and x3 respectively; J-K, CPC 19881D and E, Latex replica of internal mould of ventral valve. x2.5, latex replica of external mould of ventral valve. x2; L, CPC 19881U, Latex replica of dorsal valve internal mould. x1.75; M, CPC 19881H, Internal mould of ventral valve. x3; N, CPC 19881G, Internal mould of ventral valve. x2; O, CPC 19881 I, Latex replica of internal mould of ventral valve. x2.75; P, CPC 19880B, Shell in dorsal view. x2; Q, CPC 19880O, Latex replica of external mould of dorsal valve. x2; R, CPC 19880A, Shell in ventral view. x2.5; S, CPC 19880C, Shell in dorsal view. x1.75; T, CPC 19880W, External mould of dorsal valve. x2.5.

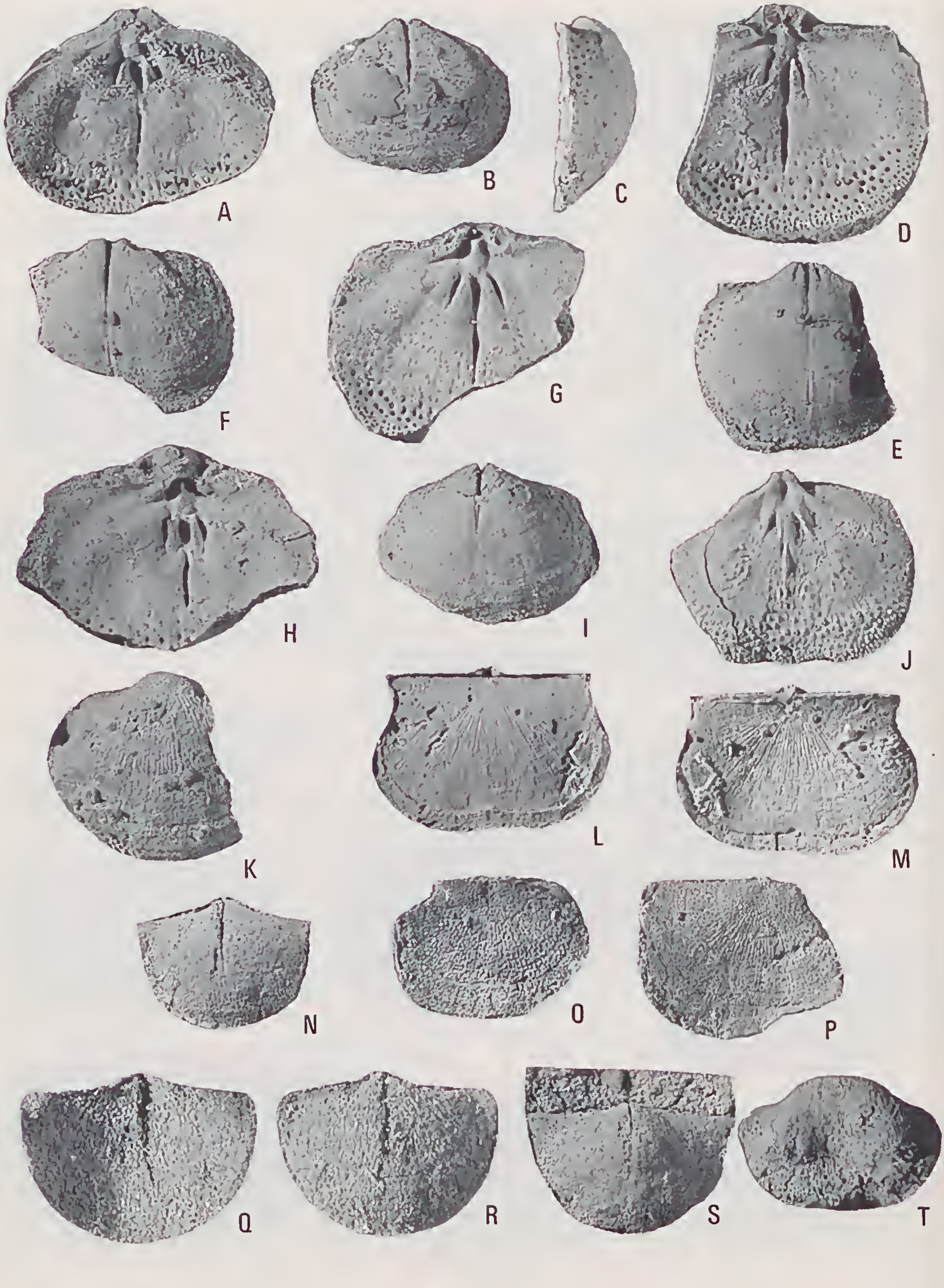

A
B
C
D
F
G
E
H
I
J
K
L
M
N
O
P
Q
R
S
T

Fig. 8 — *Neochonetes* (*Sommeria*) *robustus* sp. nov. Ventral spine arrangement of specimen CPC 19886 C, x8.

is high posteriorly and may extend anteriorly for three quarters of the valve length. The vascular trunk scars and muscle scars are usually weakly impressed but appear normal for the genus. The delthyrium is distinct for the size of the specimens; teeth are small and sharp. Margins of the interior of the ventral valve are only weakly papillose.

The dorsal interior possesses a strong median septum (about two-thirds valve length) a short, strong lateral septa. All three septa arise from a low platform around the deep, circular alveolus. The sockets are distinct with strong inner socket ridges which coalesce with the cardinal process. The cardinal process is normal for the genus. The brachial ridges are usually ill-defined and the anterior margin of the dorsal valve is papillose. The papillae are randomly arranged.

Discussion: The specimens from the Mingenew Formation are small, distinctly convex and without a sulcus. Traces of radial capillae are present on GSWA F 5285.

One crushed ventral valve, Fig. 7T, (maximum width 12.1 mm, length 7.9 mm), which is strongly convex and possesses a weakly developed sulcus from Locality 627/1, Lat. 14°26′, Long. 129°43′, 7.2 miles (11.5 km) north-north west of Table Hill, Port Keats district, Northern Territory is provisionally referred to *N.* (*S.*) *robustus* sp. nov. Dickins *et al.* (1972) considered the locality to be equivalent with the Noonkanbah Formation of the Canning Basin. The associated fauna includes *Wyndhamia* sp. nov. and *Neospirifer* sp. nov. that are otherwise restricted to the Madeline Formation

Table 5
Measurements of *Neochonetes* (*Sommeria*) *tenuicapillatus* sp. nov. (mm)
* = holotype; e = estimate

Specimen Number	Hinge Width	Maximum Width	Length Ventral	Length Dorsal	Thickness	Formation
CPC 19870	18.9	21.0	14.5	13.2	—	Bulgadoo
CPC 19871	17.2	18.6	—	11.8	—	Bulgadoo
CPC 19872	20.0e	22.0e	—	12.0+	—	Bulgadoo
CPC 19873	—	19.0	—	—	5.5e	Bulgadoo
CPC 19874	22.0e	25.0e	13.5	12.5	4.3	Quinnanie
CPC 19875	23.3	24.6	16.9	15.0	5.3	Quinnanie
CPC 19876	25.1	30.0	19.6	—	8.5e	Cundlego
CPC 19877	25.0	27.0	17.6	—	5.8	Cundlego
NMVP 60726	26.5e	28.0e	—	16.5	—	Wandagee
NMVP 60727	—	30.0e	—	—	—	Wandagee
NMVP 60728	23.2	25.5	16.8	15.6	4.2	Wandagee
NMVP 60729	24.0	25.0	12.5	—	—	Wandagee
NMVP 60730	18.5	24.0	14.0	12.6	—	Wandagee
NMVP 60731*	18.9	22.5	15.7	14.0	6.3	Wandagee
NMVP 60732	17.8	20.0	13.5	11.3	4.5	Wandagee
NMVP 60733	14.0	16.4	11.0	9.5	—	Wandagee
NMVP 60734	12.7	15.3	9.8	8.7	—	Wandagee
CPC 19879	17.7	19.7	14.0	12.5	5.0	Wandagee
NMVP 60735	22.0+	27.8	18.5	16.5	8.0	Noonkanbah
NMVP 60736	24.0e	27.0e	16.0	13.5	—	Noonkanbah
CPC 19878	15.0e	18.0e	12.5	11.5	4.0	Nalbia

Fig. 7 — *Neochonetes* (*Sommeria*) *robustus* sp. nov.
A-M, O-P, from the Madeline Formation, Carnarvon Basin; N, Q-S from equivalents of the Mingenew Formation, Perth Basin; A-B, CPC 19886E, Internal mould of shell in dorsal and ventral views. x3 and x2 respectively; C-E, Holotype, CPC 19886M, Internal mould of shell in lateral profile, dorsal and ventral views. x2.5, x3.25 and x2.5 respectively; F-G, CPC 19886O, Internal mould of shell in ventral and dorsal views. x2.5 and x3.5 respectively; H-I, CPC 19886K, Internal mould of shell in dorsal and ventral views. x3.5 and x2.5 respectively; J, CPC 19886J, Latex replica of dorsal valve internal mould. x3.25; K, CPC 19886A, Latex replica of ventral valve external mould. x2.5; L-M, CPC 19885 B, External mould of dorsal valve and latex replica. x2.5; N, GSWA F 5287, Internal mould of ventral valve. x3; O, CPC 19885E, Latex replica of dorsal valve external mould. x4; P, CPC 19886H, Latex replica of dorsal valve external mould. x3; Q-R, GSWA F 5285, External mould and internal mould of ventral valve. x4; S, GSWA F5288, Internal mould of ventral valve. x3.5; T, CPC 19169, Decorticated ventral valve in ventral view. x3; Specimen from Locality 627/1, Port Keats Group, Bonaparte Gulf Basin.

TABLE 6. SIZE RANGES OF POPULATIONS OF *Neochonetes* (*Sommeria*) *afanasyevae* sp. nov. (mm)

Formation	Maximum Width	Hinge Width	Ventral Length	Dorsal Length	Thickness
Port Keats (L.M)	15.0-22.4	12.0-21.0	10.0-14.5	10.2-13.5	–
Lightjack	8.2-28.2	10.2-27.8	6.2-12.5	10.2-17.5	1.3-1.6
Coolkilya	15.8-22.2	15.4-20.2	12.5-15.2	11.2-15.0	2.1-2.5
Total Range	9.2-28.2	10.2-27.8	6.2-15.2	10.2-17.5	1.3-2.5

indicating an Early Baigendzinian (Early Late Artinskian) age for the locality.

N. (*S.*) *robustus* sp. nov. is retained in *N.* (*Sommeria*) on the basis of the angle of the ventral hinge spines (Fig. 8) despite the distinctive shape, convexity and general lack of sulcus.

An undescribed species from the Sirius Formation of the Bowen Basin, Queensland, (Dear 1972) appears closest to the Western Australian species.

AGE: Early Baigendzinian.

Neochonetes (Sommeria) tenuicapillatus sp. nov.

Fig. 9

1915 *Chonetes pratti*; Etheridge, *Bull. geol. Surv. W. Aust.* 58: 36.

1918 *Chonetes prattei*; Etheridge, *Proc. R. geog. Soc. Aust. Sth. Aust. Brch.* 18: 25.

HOLOTYPE: NMVP 60731 from locality WC(32)1.

MATERIAL: Paratypes: (all from Carnarvon Basin) CPC 19870-19873, 2 external moulds of DV, 1 internal mould of a DV and 1 internal mould of a VV from BMR Locality MG236 (Reg. No. F20836), 3.2 km S.E. of Donnelly's Well about 33 m above base of the Bulgadoo Shale; CPC 19874-19875, 2 conjoined shells from BMR Locality ML55, N of Minilya River, 53 m above base of Quinnanie Shale; CPC 19876-19787, 2 conjoined shells, from BMR Locality F20875, approximately 14.6 km south-east of Middalya Homestead, 0.2 km north-west of well, Cundlego Formation; CPC 19879, a conjoined shell, from BMR Locality ML58, north bank of Minilya River, 40-44 m above base of Wandagee Formation, Lat. 23°44′S, Long. 114°25′E; NMVP 60726-60734, five conjoined shells, 1 VV, 1 external mould of a DV and 1 internal mould of a DV (collected by Dr. C. Teichert (1938 to 1940) on Wandagee Station on the Minilya River. (WC = Wandagee Series, *Calceolispongia* Stage) followed by the zone number (in brackets) and then the locality number. NMVP 60726-60727 from WC(36); NMVP 60728-60729 from WC(22-25)5, NMVP 60730 from WC(22-25)30; NMVP 60731 from WC(32)1; NMVP 60732 from WC(27-32)3; NMVP 60733-60734 from WC(22-25)12. CPC 19878, a conjoined shell, from BMR Locality MG247, small syncline about 4 km NNW of Wandagee Hill Trig, Nalbia Greywacke. Canning Basin: NMVP 60735-60736, 2 conjoined shells, from Mt. Marmion, Noonkanbah Formation, Canning Basin.

DESCRIPTION: EXTERNAL. The length of the shell is between two-thirds and three quarters the maximum width. The maximum width is about mid-length of the shell and is consistently greater than the hinge width. The sulcus is distinct, broadens anteriorly and is matched by a low fold on the dorsal valve. The ventral valve is strongly convex and the dorsal valve concave. Interareas are low. The chilidium, seldom preserved, is small and curved around the base of the cardinal process. The pseudodeltidium, also seldom preserved, is low and seals the apex and sides of the delthyrium. The external ornament consists of concentric growth lines, occasionally lamellose, and very fine capillae. Very slight erosion of the shell (though growth lines may still be visible) obscures the capillae. Spinule bases are minute and randomly distributed when preserved. Hinge spines emerge at about 40° to the hinge and are short.

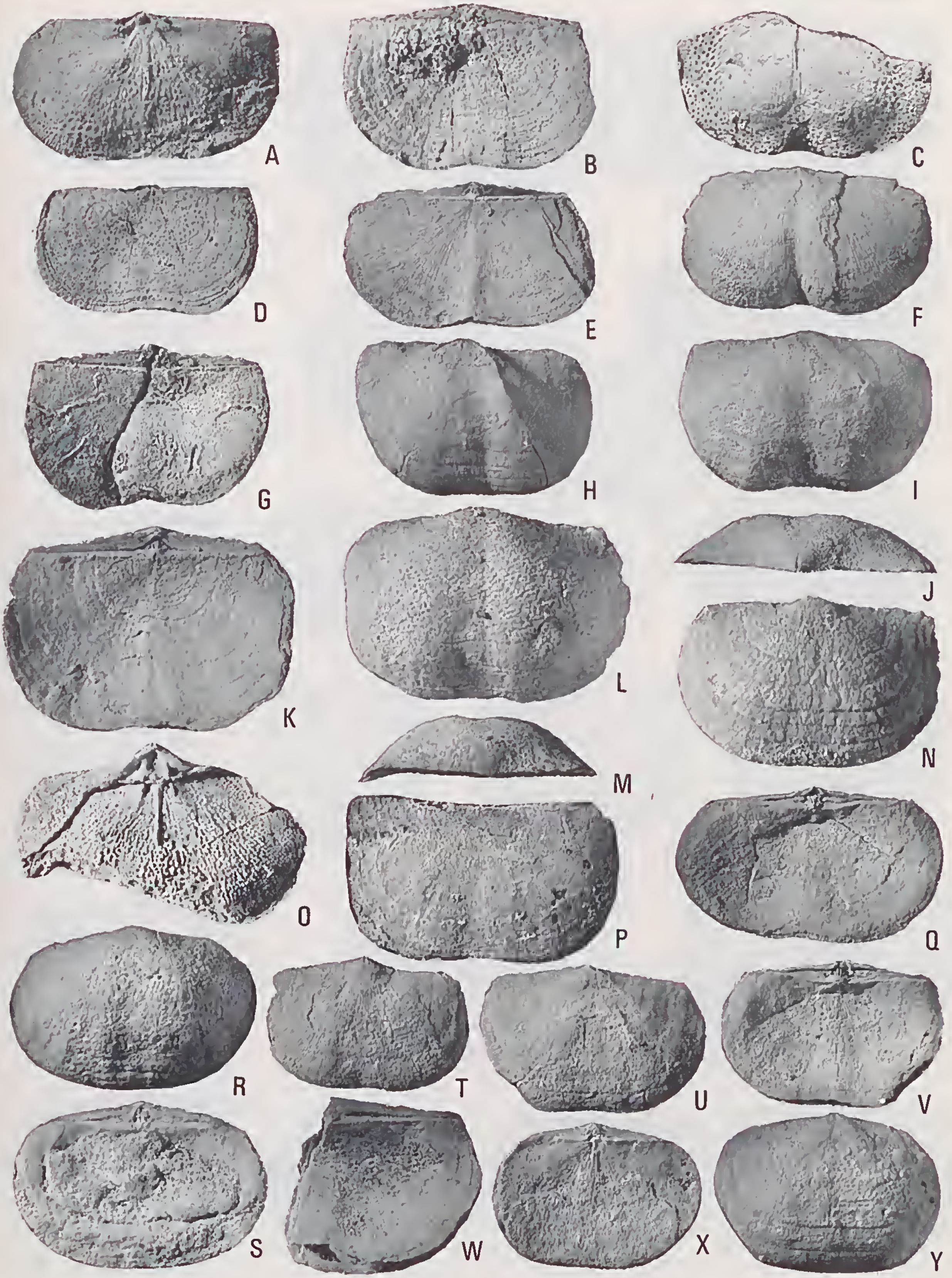
INTERNAL. The ventral septum arises close to the umbo and is up to half the valve length. Parallel vascular trunks and muscle scars are usually weakly impressed. The teeth are small and sharp; the delthyrium small. The margins of the interior of the ventral valve are papillose.

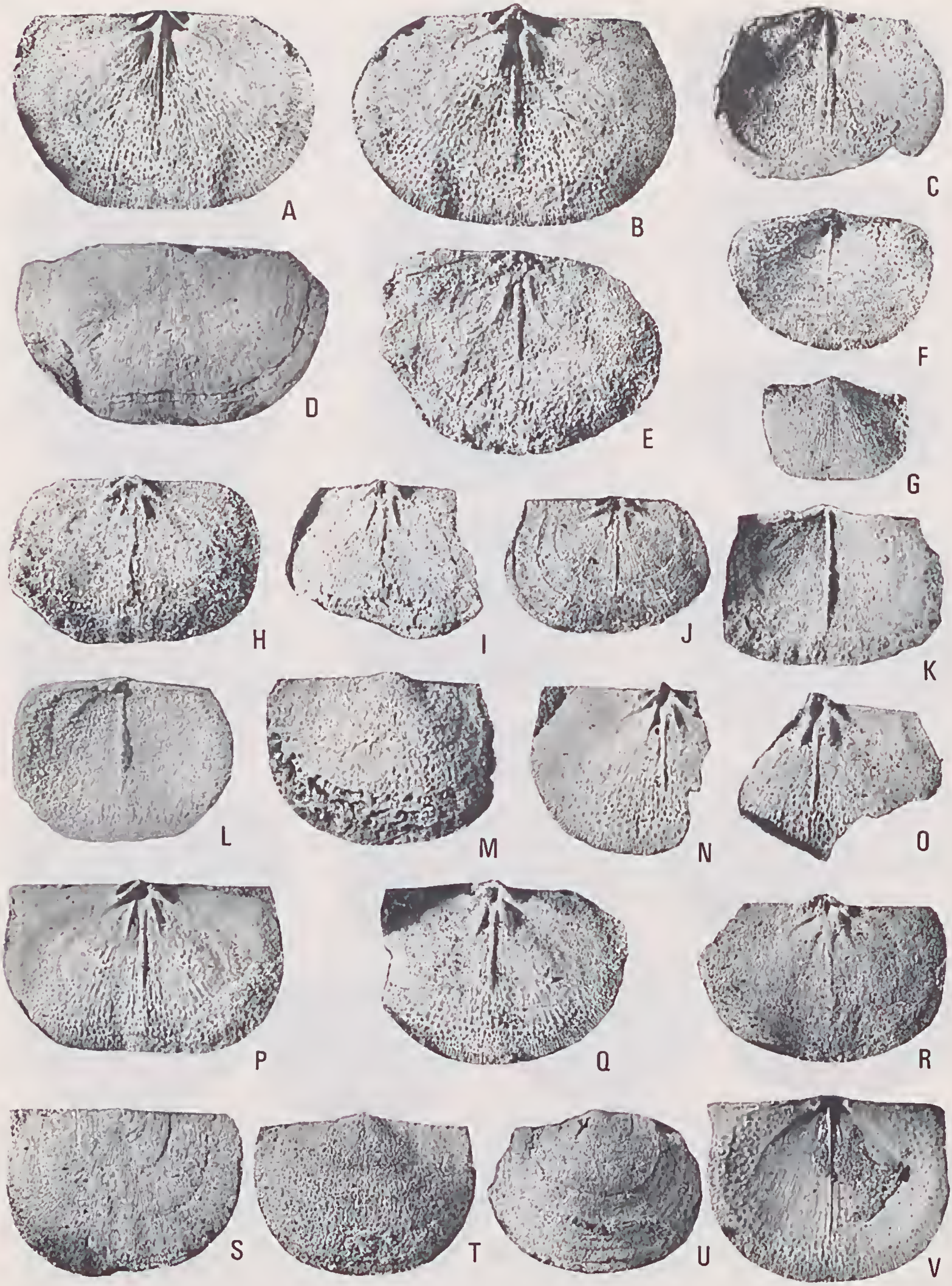
The dorsal interior possesses a median septum which is between half and two-thirds the valve length. The lateral septa are short and strong and all three septa arise anteriorly of a distinct, circular alveolus. The sockets are deep with pronounced inner socket ridges and feeble outer socket ridges. The inner socket ridges coalesce with the cardinal process which is normal for the genus. The brachial ridges are not distinct, even in mature specimens. The anterior of the interior of the dorsal valve can be thickly papillose; the papillae are randomly arranged.

DISCUSSION: *Neochonetes* (*Sommeria*) *tenuicapillatus* is

Fig. 9—*Neochonetes* (*Sommeria*) *tenuicapillatus* sp. nov.

A-D from the Bulgadoo Shale, Carnarvon Basin; E-G from the Quinnanie Shale, Carnarvon Basin; H-J from the Cundlego Formation, Carnarvon Basin; K-Q, T-V from the Wandagee Formation, Carnarvon Basin; specimens R, S, W, from the Noonkanbah Formation, Canning Basin; specimen X-Y from the Nalbia Greywacke, Carnarvon Basin; A, CPC 19872, Latex replica of dorsal valve internal mould. x2; B, CPC 19870, Latex replica of dorsal valve external mould, x2; C, CPC 19873, Internal mould of ventral valve. x2; D, CPC 19871, Latex replica of dorsal valve external mould. x1.75; E-F, CPC 19874, Shell in dorsal and ventral views. x1.75; G, CPC 19875, Shell in dorsal view. x1.75; H, CPC 19876, Shell in ventral view. x1.25; I-J, CPC 19877, Shell in ventral and posterior views. x1.5; K-M, Holotype NMV P60731, Shell in dorsal, ventral and posterior views. x2, x2 and x1.5 respectively; N, NMV P 60732, Shell in ventral view. x2; O, NMV P 60727, Latex replica of dorsal valve internal mould. x1.5; P, NMV P 60726, Dorsal valve external mould. x1.5; Q, NMV P 60730, Shell in dorsal view. x1.75; R-S, NMV P 60735, Shell in ventral and dorsal views. x1.5; T, NMV P 60734, Shell in ventral view. x2.5; U-V, NMV P 60733, Shell in ventral and dorsal views. x2.25; W, NMV P 60736, Incomplete shell in dorsal view. x1.75; X-Y, CPC 19878, Shell in dorsal and ventral views. x2 and x2.5 respectively.


A
B
C
D
E
F
G
H
I
J
K
L
N
M
O
P
Q
R
T
U
V
S
W
X
Y


A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
U
V

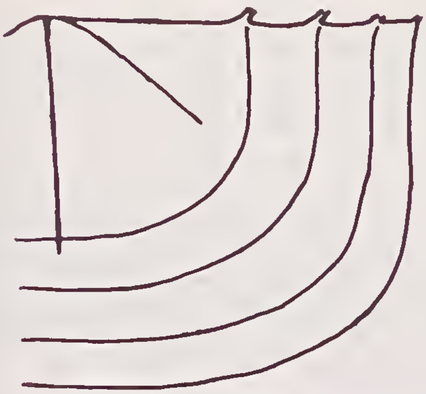


Fig. 11—*Neochonetes* (*Sommeria*) *afanasyevae* sp. nov. Ventral spine arrangement of specimen CPC 19887A, x8.

chiefly distinguished from *N.* (*S.*) *pratti* by the very fine, delicate external ornament. Brachial ridges and ventral muscle scars do not appear to be as strongly developed as in *N.* (*S.*) *pratti*, although these features are probably not of specific importance.

N. (*S.*) *tenuicapillatus* is closest to *Neochonetes* (*Sommeria*) *fredericksi* Archbold (1979) from the Artinskian (probably Aktastinian) of the Pechora Basin. The latter species has a length about two-thirds the maximum width of the shell and about 5 capillae per 1 mm.

Chonetes dubia Hamlet (1928) from Bitauni and Noil Toko, Timor, of Late Baigendzinian age is similar in outline, size and convexity to *Neochonetes* (*Sommeria*) *tenuicapillatus*, but differs by possessing higher interarcas and a more prominent ventral umbo. *Chonetes dubia* exhibits weakly developed radial ornament (Hamlet 1928, pl. 1, figs 12, 14b).

RANGE: Late Baigendzinian to Early Kungurian.

Neochonetes (Sommeria) afanasyevae sp. nov.

Fig. 10

1906 *Chonetes* sp. (? *C.pratti*); Etheridge, *S. Aust. Parl. Paper* 55: 41.
1907 *Chonetes* sp. (? *C.pratti*); Etheridge, *S. Aust. Parl. Paper* 54: 7, pl. 6, fig. 9.
1909 *Chonetes pratti*(?); Basedow, *Z. deutschen Geol. Gesell.*, 61(3): 325.
1952 *Chonetes pratti*; Guppy *et al.*, *19th Int. Geol. Cong., Alger., Sym. Gond.*, 111.

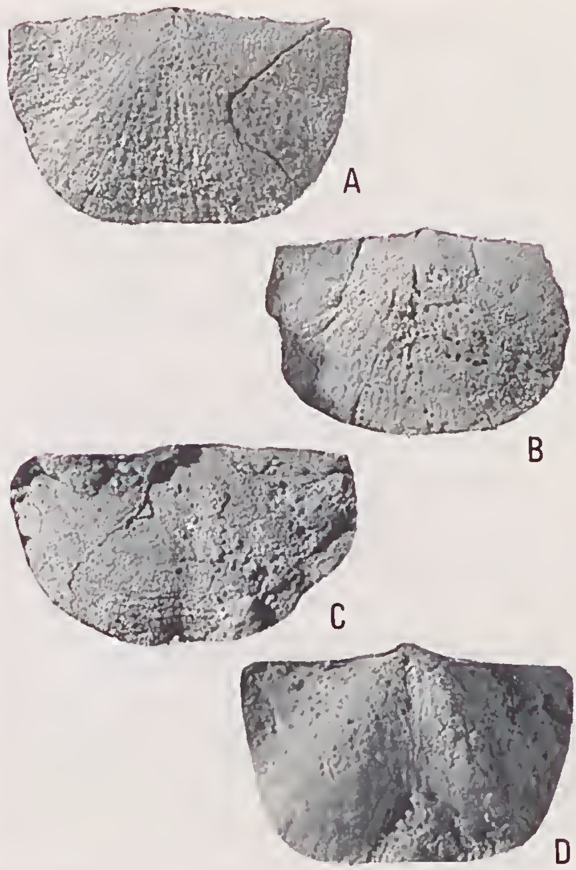


Fig. 12—A-C, *Neochonetes* (*Sommeria*) sp. A
All specimens from the Hardman Formation, Canning Basin. A, CPC 19883. Ventral valve in ventral view. x4; B, CPC 19882, Ventral valve in ventral view. x3.75; C, CPC 19884, Latex replica of ventral valve external mould. x1.25.
D, *Chonetinella* sp.
Coolkilya Greywacke, Carnarvon Basin. UWA 88108, Decorticated ventral valve in ventral view. x4.25.

1957 *Chonetes* sp. Thomas, *J. Pal. Soc. India*, 2: 180.
1958a *Chonetes* sp. Thomas, *Abstracts ANZAAS* 1958, Sec. C., p. 2.

HOLOTYPE: CPC 19902A from locality 1027A or 1095. These are similar sections some 2 to 4 km apart on the same ridge. The collections were inadvertently mixed.

Fig. 10—*Neochonetes* (*Sommeria*) *afanasyevae* sp. nov.
A-G from the Lightjack Formation, Canning Basin; H-M from the Lower Marine Beds, Port Keats Group, Bonaparte Gulf Basin; N-V from the Coolkilya Greywacke, Carnarvon Basin. A-B, Holotype CPC 19902A, Dorsal valve internal mould and latex replica, x2.25; C, CPC 19901A, Latex replica of ventral valve internal mould, x2; D, CPC 19900, External mould of dorsal valve, x2; E, CPC 19889B, Natural cast of dorsal valve, x2; F, CPC 19902C, Latex replica of ventral valve internal mould, x3.5; G, CPC 19902E, Latex replica of ventral valve external mould, x3; H, CPC 19887C, Natural cast of dorsal valve, x2.5; I, CPC 19888C, Latex replica of dorsal valve internal mould, x2; J, CPC 19888D, Latex replica of dorsal valve internal mould, x2.5; K, CPC 19887B, Natural cast of ventral valve, x2.5; L, SMP 2131, Natural cast of ventral valve, originally figured by Etheridge (1907a, pl. 6 fig. 9), x2; M, CPC 19887A, Latex replica of ventral valve external mould, x2.5; N, CPC 19904D, Latex replica of dorsal valve internal mould, x2.25; O, CPC 19908B, Latex replica of dorsal valve internal mould, x2.25; P, CPC 19907A, Latex replica of dorsal valve internal mould, x2; Q, CPC 19909C, Latex replica of dorsal valve internal mould, x2.5; R, CPC 19905B, Latex replica of dorsal valve internal mould, x2; S, CPC 19907D, Latex replica of dorsal valve external mould, x2.5; T, CPC 19905A, Latex replica of ventral valve external mould, x2.5; U, 19909A, Latex replica of ventral valve external mould, x2; V, CPC 19907B, Latex replica of ventral valve internal mould, x2.75.

ETYMOLOGY: For Dr. G. A. Afanas'yeva for her substantial contributions to the study of chonetacean brachiopods.

MATERIAL: Paratypes. CPC 19887A-19887D, 19888A-19888D 1 natural ferruginous cast of a DV and 2 natural casts of VV, 1 external mould of a DV, 2 internal moulds of DV and 1 internal mould of a VV from Fossil Head, south of Port Keats Mission, Bonaparte Gulf, Northern Territory, Lower Marine Beds, Port Keats Group; CPC 19889A-19889B, 1 natural cast of a DV and 1 natural cast of a VV, from BMR Locality 1027A, Lat. 17°54′15″S, Long. 123°52′15″E, Lightjack Formation, Liveringa Ridge, Canning Basin; CPC 19901A-19901C, 19902B-19902E, 3 internal moulds of VV, 3 external moulds of VV and 1 internal mould of a DV, from BMR Locality 1027A or Locality 1095, Lat. 18°04′40″S, Long. 124°03′00″E, Lightjack Formation, Liveringa Ridge; CPC 19900, 1 external mould of a dorsal valve, from BMR Locality KLA3, Bore near Liveringa Homestead, Lightjack Formation; CPC 19903, 19904A-D, 19905A, B, 19906, 19907A-D, 3 internal moulds of VV, 1 external mould of a VV, 4 internal moulds of DV and 4 external moulds of DV from BMR Locality F 17060, ridge and outliers of Kennedy Range, traverse NW of Paddy's Outcamp by Teichert, Thomas and Johnstone 1948, Coolkilya Greywacke, Carnarvon Basin; CPC 19908A, B, 19909A-D 3 internal moulds of VV, 2 internal moulds of DV and 1 external mould of a DV, from BMR Locality F 17082, 1.2 km SE of Southern Cross Bore, Middalya Station, Coolkilya Greywacke.

DIAGNOSIS: Planar-convex; ventral valve weakly convex; sulcus obsolescent; exterior ornament of fine capillae; ventral and dorsal septa distinct but thin and sharp.

DESCRIPTION: EXTERNAL. Length of the shell is between 0.67 and 0.75 of maximum width. Maximum width is about mid-length of the shell and is greater than hinge width. Interareas are low. Pseudodeltidial and chilidial structures have not been preserved on any specimens. The external ornament consists of concentric growth lines, occasionally lamellose, and fine capillae which are spaced, on average, 5 per mm at 1 cm from the umbo and between 4 and 5 per mm at 2 cm from the umbo; they increase in number by both bifurcation and intercalation. Weathering may obscure the capillae and yet leave prominent growth lamellae. Hinge spines are poorly known, and are short and emerge at 40°-45° to the hinge.

INTERNAL. The ventral septum arises close to the umbo, under the delthyrium, and is up to three-quarters of the valve length. The septum is thin and sharp. Parallel vascular trunks are usually absent and smooth muscle scars are weakly impressed. The teeth are small and sharp and the delthyrium is small. Interior margins of the ventral valve are weakly papillose.

The dorsal interior possesses a median septum which is about two-thirds the valve length; it is thin and sharp. The lateral septa are short, at a small angle to the median septum, and are thin and strong. All three septa arise anteriorly of a distinct, circular alveolus. The sockets are small, yet distinct, with small, sharp inner socket ridges and feeble outer socket ridges. The inner socket ridges coalesce with the cardinal process which is small, externally quadrilobate and internally bilobate. The brachial ridges are never strongly developed and the anterior of the interior of the valve is finely papillose.

DISCUSSION: *Neochonetes* (*Sommeria*) *afanasyevae*, is a distinctive species of the genus, with few recorded species possessing comparable morphological characters. *Neochonetes* sp. of Bamber & Waterhouse (1971, pl. 19, figs. 13-18) from the Lower Ufimian of the North Richardson Mountains, Yukon Territory is similar in size, shell outline, dorsal interior and development of the brachial ridges, weakly developed sulcus, and weak external ornament.

The near absence of the sulcus makes *N.* (*S.*) *afanasyevae* atypical for the subgenus *Sommeria*. However, the species is retained in the subgenus because of the angle of the hinge spines (Fig. 11).

RANGE. Middle Kungurian.

Neochonetes (Sommeria) sp. A.

Fig. 12 A-C.

MATERIAL: CPC 19882-19883, 2 small VV, from BMR Locality KLB 11, Mount Hardman, from beds 1.25 m thick at about 40 m below top of hill, Hardman Formation, Canning Basin; CPC 19884, external mould of large VV, from BMR Locality CR 1188, Lat. 19°30′00″S, Long. 125°32′15″E, Hardman Formation, Canning Basin.

TABLE 7

MEASUREMENTS OF *Neochonetes* (*Sommeria*) SP. A (MM)

Specimen Number	Hinge Width	Mid Width	Ventral Length	Locality
CPC 19882	8.6	9.8	6.8	KLB 11
CPC 19883	10.9	10.3	7.3	KLB 11
CPC 19884	31.0e	29.0e	17.6	CR 1188

OBSERVATIONS: This distinct species is large, the maximum width is not always coincident with the hinge width. The sulcus is broad and deep in its centre. Exterior ornament of capillae is relatively coarse with between 2 and 3 per mm. Convexity of the ventral valve is not pronounced.

COMPARISONS: Despite the inadequate material these specimens appear closely comparable with *Neochonetes* (*Sommeria*) *wageri* (Muir-Wood, in Muir-Wood & Oakley 1941) in outline and thickness. However, Muir-Wood's species possesses finer ornament and a shallower sulcus.

AGE: Chhidruan.

Subfamily CHONETINELLINAE Muir-Wood 1962

Genus **Chonetinella** Ramsbottom 1952

TYPE SPECIES: *Chonetes flemingii* Norwood & Pratten 1855.

DIAGNOSIS: Strongly concavo-convex, capillate rugosochonetids with a prominent, narrow ventral sulcus and distinct dorsal fold.

DISCUSSION: *Chonetinella* has been broadly interpreted by Grant (1976) to include species which approach representatives of *Neochonetes* (*Sommeria*) subgen.

nov. However, as no material from Western Australia adds to the understanding of the genus, *Chonetinella* is not discussed further here.

Chonetinella sp.

Fig. 12 D.

MATERIAL: UWA 88108, one decorticated VV, from UWA Locality WF 8.5 (registered no. 28011); *Thamnopora* horizon, 1300 links south of gate in Shed Paddock, Wandagee Station, (collector Dr. C. Teichert), Coolkilya Greywacke, Carnarvon Basin.

MEASUREMENTS: Maximum width 11 mm, hinge width 10 mm, length of valve 7 mm, thickness estimated at 3.5 mm.

OBSERVATIONS: Its small size, distinct convexity and narrow deep sulcus refer it to *Chonetinella*. Traces of capillae are visible on the anterior portion of the valve. The specimen indicates the presence of a distinct, highly sulcate chonetid in the higher portion of the Permian sequence of the Carnarvon Basin.

AGE: Middle Kungurian.

ACKNOWLEDGEMENTS

I thank Dr. J. M. Dickins, Bureau of Mineral Resources, Geology and Geophysics, Dr. P. Jell, National Museum of Victoria and Dr. A. E. Cockbain, Geological Survey of Western Australia, for providing specimens from collections in their care. Dr. G. A. Thomas, University of Melbourne, and two reviewers provided fruitful comments. The assistance of the staff of the Baillieu Library, University of Melbourne is acknowledged. Val Le Maitre and Isabel McDonald typed the manuscript. The work was carried out while the author was in receipt of a University of Melbourne Postgraduate Award.

REFERENCES

References supplementary to those in Archbold 1980a.

ACHARYYA, S. K., GHOSH, S. C., GHOSH, R. N. & SHAH, S. C., 1975. The Continental Gondwana Group and associated marine sequences of Arunuchal Pradesh (NEFA) Eastern Himalaya. *Himalayan Geology* 5: 60-81.

AFANAS'YEVA, G. A., 1975b. Chonetacea (Brachiopoda) srednego i pozdnego karbona Russkoy platformy. *Paleont. Zhur.* 1975(2): 96-113.

ARCHBOLD, N. W., 1979. Revision of two Permian brachiopod species names. *J. Paleont.* 53: 1260.

ARCHBOLD, N. W., 1980a. Studies on Western Australian Permian brachiopods. 1. The family Anopliidae (Chonetidina). *Proc. R. Soc. Vict.* 91: 181-192.

ARCHBOLD. N. W., 1980b. *Mingenewia* n. gen. (Strophalosiidina, Brachiopoda) from the Western Australian Permian. *J. Paleont.* 54: 253-258.

ARCHBOLD, N. W., 1981a. *Quinquenella* (Chonetidina, Brachiopoda) from the Permian of Western Australia. *J. Paleont.* 55: 204-210.

ARCHBOLD, N. W., 1981b. *Svalbardia* (Chonetidina, Brachiopoda) from the Kungurian (Permian) of Western Australia. *Alcheringa* 5: 1-8.

ARCHBOLD, N. W., 1981c. Western Australian Geology: An historical review to the year 1870. *J. Roy. Soc. W. Aust.* 63: 119-128.

BOGOSLOVSKAYA, M. F., 1976. Kungurskiya ammonoidei srednego Predural'ya. *Paleont. Zhur.* 1976(4): 43-50.

BRANSON, C. C., 1964. *Neochonetes oklahomensis* (Snider). *Okla. Geol. Notes.* 24: 95-97.

COCKBAIN, A. E., 1980. Permian ammonoids from the Carnarvon Basin—A review. *Annu. Rep. Geol. Surv. W. Aust.*, 1979: 144-149.

CROWE, R. W. A. & TOWNER, R. R.,1976. Permian stratigraphic nomenclature Noonkanbah 1:250,000 sheet. *Annu. Rep. Geol. Surv. W. Aust.* 1975: 56-58.

CZARNIECKI. S., 1969. Sedimentary environment and stratigraphical position of the Treskelodden Beds (Vestspitsbergen). *Prace Museum Ziemi, Warsaw.* 16: 201-336.

DAVIDSON, T., 1859. Palaeontological notes on the Brachiopoda. No. 2. On the families Strophomenidae and Productidae. *Geologist* 2: 97-117.

DAVIDSON, T., 1880. A monograph of the British fossil Brachiopoda. Volume 4, Part 3. Supplement to the British Permian Brachiopoda. *Palaeontograph. Soc. Mon.* 34: 243-248.

DEAR, J. F., 1971. Strophomenoid brachiopods from the higher Permian faunas of the Back Creek Group in the Bowen Basin. *Publs. geol. Surv. Qld.*, 347, *Palaeont. Pap.* 21: 1-39.

DICKINS, J. M., 1956. Permian pelecypods from the Carnarvon Basin, Western Australia. *Bull. Bur. Miner. Resour. Geol. Geophys. Aust.* 29: 1-42.

DICKINS, J. M., 1976. Correlation chart for the Permian System of Australia. *Bull. Bur. Miner. Resour. Geol. Geophys. Aust.* 156B: 1-26.

DICKINS, J. M. & JELL, P. A., 1974. Permian fossils from the Canning Basin, 1971 and 1972. *Bur. Miner. Resour. Geol. Geophys. Aust., Record* 1974/77: 1-14. (Unpubl.)

DICKINS, J. M., ROBERTS, J. & VEEVERS, J. J., 1972. Permian and Mesozoic geology of the northeastern part of the Bonaparte Gulf Basin. *Bull. Bur. Miner. Resour. Geol. Geophys. Aust.* 125: 75-102.

D'ORBIGNY, A., 1842. *Voyages dans L'Amerique meridionale execute pendant les annees 1826, 1827, 1828, 1829, 1830, 1831, 1832 et 1833.* Tome 3; 4.e Partie: Paleontologie. Bertrand, Paris. Levrault, Strasbourg.

DOUGLAS, J. A., 1936. A Permo-Carboniferous fauna from Southwestern Persia (Iran). *Mem. geol. Surv. India Palaeont. indica.* N.S. 22, 6: 1-59.

DUNBAR, C. O., & CONDRA, G. E., 1932. Brachiopoda of the Pennsylvanian System of Nebraska. *Bull. geol. Surv. Neb. Ser.* 2, 5: 1-377.

ELIAS, M. K., 1962. Comments on recent paleoecological studies of Late Paleozoic rocks in Kansas. *Kansas geol. Soc., 27th Field Conf., Guidebook* 106-115.

ELIAS, M. K., 1966. Depth of Late Paleozoic Sea in Kansas and its megacyclic sedimentation. *Bull. geol. Surv. Kansas* 169(1): 87-106.

FANTINI SESTINI, N., 1964. Diagnosi di forme nuove, *Neochonetes asseretoi* sp. n. *Riv. Ital. Pal. Strat.* 70: 899.

FANTINI SESTINI, N., 1965a. The geology of the Upper Djadjerud and Lar Valleys (North Iraň). II Paleontology. Bryozoan, brachiopods and molluscs from Ruteh Limestone (Permian). *Riv. Ital. Pal. Strat.* 71: 13-110.

FANTINI SESTINI, N., 1965b. Permian fossils of the Shaksgam Valley. In, *Italian Expedition to the Karakorum (K2) and Hindukush. Sci. Rep. IV, Paleont. Zool. Bot.* 149-215. E. J. Brill, Leiden.

FREDERICKS, G. N., 1915. Fauna verkhne paleozoiskoi Tolshchi/okrestnostei goroda Krasnoufimska Permskoi

Gub. *Trudy geol. Kom.* N.S. 109: 1-117.

Glenister, B. F. & Furnish, W. M., 1961. The Permian ammonoids of Australia. *J. Paleont.* 35: 673-736.

*Gorskii, I. I. & Timofeeva, I. L., 1950. Verkhnepaleozoiskaya fauna iz Dzhon-garskogo Alatay. *Petrozavodsk, Karelo Finskii Gos. Univ.* pp. 1-82.

Grunewaldt, M. Von., 1860. Beitrage zur kenntniss der Sedimentaren Gebirgsformationen in den Berghauptmannschaften Jekatherinburg, Slatoust and Kuschwa, sowie den angrenzenden Gegenden des Ural. *Mem. Acad. imp. Sci. St. Petersbourg. Ser.* 7, 2, 7: 1-144.

Grushenko, N. V., 1975. Brakhiopody nizhnei permi i ix znachenie dlya stratigrafii vostochno-Ukrainskogo nefterazonosnogo basseina. In, Lapkin, Yu, (ed.), *Stratigrafiya verkhnego paleozoya i nizhnego mezozoya dneprovsko-donetskoi bpadniy.* Moskva, "Nedra", pp. 83-118.

Guppy, D. J., Lindner, A. W., Rattigan, J. H. & Casey, J. N., 1952. The stratigraphy of the Mezozoic and Permian sediments of the Desert Basin, Western Australia. *19th Int. Geol. Cong. Alger., Sym. Gond.*, 107-114.

Hamlet, B., 1928. Permische Brachiopoden, Lamellibranchiaten und Gastropoden von Timor. *Jaarboek van het Mijnwezen in Nederlands Indie.* 56(2): 1-115.

Hudson, R. G. S. & Sudbury, M., 1959. Permian Brachiopoda from south-east Arabia. *Notes, Mem. Moyen-Orient, Mus. nat. Hist. nat.*, 7: 19-55.

Keyserling, A. F. M. L. A. Von, 1846. *Wissenschaftlich Beobachtung auf einer Reise in das Petschora-Land im Jahre 1843.* Carl Kray, St. Petersburg, pp. 1-336.

King, R. H., 1938. New Chonetidae and Productidae from the Pennsylvanian and Permian strata of north-central Texas. *J. Paleont.* 12: 257-279.

Koninck, L. G. de, 1847. *Recherches sur les animaux fossiles. I. Monographie des genres Productus et Chonetes.* H. Dessain. Liege. 246 pp.

Kozlowski, R., 1914. Les Brachiopodes due Carbonifere superieur de Bolivie. *Ann. paleont.* 9, 1-100.

Kulikov, M. V., 1974. O rasselenii i usloviyakh obitaniya fauny v severnoi chasti Kazanskogo morya. *Trudy Vses. ordena Lenina nauchno-issled. geol. Inst.* (VSEGEI) *n.s.* 182: 138-153.

Lapina, N. N., 1958. Nekotorye dannye o brakhiopodovoi fauna verkhnego paleozoya severnoi chasti Kharaulakhskikh gor. *Nauchno-issled. Inst. Geol. Arkt., Sb. Strat. Paleont. Biostratigr.*, 8: 21-30.

Liao Zhuo-Ting, 1979. Uppermost Carboniferous brachiopods from Western Guizhou. *Acta palaeont. sin.*, 18, 527-546.

Licharew, B. K., (Likharev, B. K.), 1913. Fauna permskikh' otlozhenii okrestnostei goroda Kirillova Novgorodskoi Gubernii. *Trudy Geol. Kom.* N.S. 85: 1-99.

Malzahn, E., 1957. Neue fossil funde und vertikale verbreitung der niederrheinischen Zechsteinfauna in den Bohrungen Kamp 4 und Friedrich Heinrich 57 bei Kamp-Lintformt. *Geol. Jb.* 73: 91-126.

Muir-Wood, H. M. & Oakley, K. P., 1941. Upper Palaeozoic faunas of north Sikkim. *Mem. geol. Surv. India. Palaeont. indica* N.S. 31, 1-91.

Newton, R. B., 1892. On the occurrence of *Chonetes pratti*, Davidson, in the Carboniferous rocks of Western Australia. *Geol. Mag.*, (3) 9: 468-469, 542-544.

Newton, R. B., 1893. On the occurrence of *Chonetes pratti*, Davidson in the Carboniferous rocks of Western Australia. *Rep. Br. Ass. Advmt. Sci. for 1892*, 725-726.

Owen, D. D., 1852. *Report of a Geological Survey of Wisconsin, Iowa and Minnesota and incidentally of a portion of Nebraska Territory.* Philadelphia, Lippincott, Grambo and Co. pp. 1-638.

Ozaki, K., 1934. On some brachiopods from the reddish purple shale of the Koten series exposed in the Heizyo coal field. *J. Shanghai Sci. Inst. Sec.* 2, 1: 89-98.

Playford, P. E., Cockbain, A. E. & Low, G. H., 1976. Geology of the Perth Basin, Western Australia. *Bull. geol. Surv. West. Aust.* 124: 1-311.

Sahni, M. R. & Srivastava, J. P., 1956. Discovery of *Eurydesma* and *Conularia* in the eastern Himalaya and description of associated faunas. *J. Pal. Soc. India* 1(1): 202-214.

Sarycheva, T. G. 1970. *Slovar' terminov po morfologii produktid (Brachiopoda).* Moskva, Nauka. 84 pp.

Schauroth, K. F., 1856. Ein neuer beitrag zur Paläontologie des deutschen Zechsteingebirges. *Zeit. deutsch. geol. Ges.* 8: 211-245.

Schellwein, E., 1911. Palaozoische und Triadische fossilien in Ostasian. In, Futterer, K. (ed.)., *Durch Asien*, Vol. 3, pp. 125-174. Dietrich Reimer. Berlin.

Semenova, E. G., 1972. Brakhiopody bashkirskogo yarusa i vereiskogo gorizonta Kuibyshevskoi oblasti. In, Ifanova, V. V. & Semenova, E. G. *Srednekamennougol'nye i permskie brakhiopody vostoka i severa evropeiskoi chasti SSSR* pp. 7-68. Akad. Nauk SSSR "Nauka". Moskva.

Sokolskaya, A. N., 1965. Podotryad Chonetoidea. In, Ruzhentsev, V. E. & Sarycheva, T. G., Razvitie i smena morskikh organizmov na rubezhe paleozoya i mesozoya. *Akad. Nauk SSSR, Paleont. Inst., Trudy* 108: 209-211.

Spencer, R. S., 1970. Evolution and geographic variation of *Neochonetes granulifer* (Owen) using multivariate analysis of variance. *J. Paleont.* 44: 1009-1028.

Termier, G., Termier, H., Lapparent, A. F. De & Marin, P., 1974. Monographie due Permo-Carbonifere de Wardak. *Doc. Lab. Geol. Fac. Sci. Lyon., H.S.* 2: 1-167.

Thomas, G. A., 1958. Ther Permian Orthotetacea of Western Australia. *Bull. Bur. Miner. Resour. Geol. Geophys. Aust.* 39: 1-158.

Thomas, H. D., 1930. An Upper Carboniferous fauna from the Amotape Mountains, North-Western Peru. *Geol. Mag.* 67: 394-408.

Trechmann, C. T., 1944. On some new Permian fossils from the Magnesian Limestone near Sunderland. *Q. Jl. geol. Soc. Lond.* 100: 333-354.

Waterhouse, J. B., 1964. Permian brachiopods of New Zealand. *N.Z. geol. Surv. paleont. Bull.* 35: 1-289.

Winkler-Prins, C. F., 1968. Carboniferous Productidina and Chonetidina of the Cantabrian Mountains (N.W. Spain): Systematics, stratigraphy and palaeoecology. *Leid. geol. Meded.* 43: 41-126.

Woodward, H. B., 1907. *The History of the Geological Society of London.*Geological Society. London. 336 pp.

Yeates, A. N., Crowe, R. W. A., Passmore, V. L. Towner, R. R. & Wyborn, L. I. A., 1975. New and revised stratigraphic nomenclature, northeast Canning Basin. *Annu. Rep. geol. Surv. W.Aust.* 1974: 49-51.

Zavodovsky, V. M. & Stepanov, D. L., 1971. Typ Brachiopoda. In, Kulikov, M. V. (ed.). *Polevoi Atlas permskoi fauny i flory Severo-Vostoka SSSR.* Magadanskoe Knizhnoe Izd-vo. Magadan. pp. 70-182.